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General Mills, Inc.

Mechanical Division

ENGINEERING RESEARCH & DEVELOPMENT DEPARTMENT

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This document consists of 14 pages and is number 22 of 36 copies, series B, and the following attachments. appendix

PROGRESS REPORT

Contract No. Nonr 875(00)
Annex XII
June 1, 1954

Prepared for

The Office of Naval Research
Washington 25, D. C.

Report No. 1312

Prepared by: F. Bartholomew

Approved by:

Cledo Brunetti
Cledo Brunetti, Director

GENERAL MILLS, INC.
Mechanical Division
ENGINEERING RESEARCH AND DEVELOPMENT
2003 E. Hennepin Ave.
Minneapolis 13, Minn.

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PROGRESS REPORT

Contract No. Nonr 875(00)
Annex XII
June 1, 1954

SUMMARY

When the preceeding progress report was written for the period leading up to 1 April 1954, the following items had been accomplished:

1. The theory of the super-pressure balloon upon which the work under this project is based had been formulated, and the material requirements for strength and elastic modulus had been derived.

2. Certain materials and combinations of materials had been chosen for investigation on the basis of their properties at room temperature, with plans for determining their low temperature properties under this project.

3. Four major types of balloon designs had been selected as being feasible:

a. A nylon fabric cover containing a polyethylene or rubber bladder.

b. An onion-shaped cylinder balloon of Saran or of polyethylene-Mylar laminate.

c. A sphere of Saran alone.

d. A sphere of polyethylene impregnated fiberglas.

Balloons of type a. had been made and were ready for tests. Fabrication of balloons of type b. awaited the arrival of material. Balloons of type c. cannot be made until a mobile electronic sealer has been developed. The problems of such a sealer were under study, and the drawings for an applicable type had been obtained from Dow Chemical Company, makers of Saran film. Investigation of balloons of type d. had just begun.

4. The technique for obtaining a measure of relative superheat among balloon materials had been developed, and a preliminary run of materials on hand had been made.

5. One flight on a 25 ft. open appendix balloon had been made to investigate the relative upward and downward radiation during night-time.

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I. ENGINEERING STUDY

A. Further Discussion of Super-pressure Balloon Theory

On May 11, the writer discussed the work under this project with Dr. Ney, Dr. Winckler, Mr. Huch, and Cdr. Sparkman, in Dr. Ney's office at the University of Minnesota. Recent flights of super-pressure balloons flown by the University of Minnesota were described. Measurements of superheat in terms of per cent gain of lift had been made by the University of Minnesota at several levels in the atmosphere in what they have come to call a "Step" flight. The data so obtained indicate that the sunset effect increases with altitude, at least to 50,000 feet MSL. At this level, approximately five per cent sunset effect was experienced with a 2 mil polyethylene balloon. The sunset effect may reach eight per cent at higher levels.

Eight per cent increase of lift, if contained, represents only 3.5 inches of water internal pressure at 100 millibars, where the minimum superheat would be experienced. At 200 millibars, it represents 6.4 inches of water. Our stress requirements have been built around an assumption of 16 inches of water super-pressure. Apparently as much as ten per cent free lift can be contained in addition to the superheat energy, if these figures apply to our balloons.

During the discussion, Dr. Ney raised the question of what advantage is gained by using thick film. His reference was to the theory that superheat is essentially a function of the mass of the balloon, and that increasing the thickness of the balloon walls merely increases the amount of superheat proportionately, so that nothing is gained in the effort to provide sufficient strength. From this theory, he has concluded that the thinnest material is the best for the job.

His question was answered with the following points.

1. We question the theory. Dr. Ney, himself, agrees that it would not be unreasonable to suppose that, above a certain thickness and a certain superheat value, the increase of thickness would become less and less effective in increasing the superheat. Since we are working with an increasing temperature gradient between the balloon wall and the ambient air, it seems that this should be true. We are dealing with a situation where a certain maximum superheat probably will not be exceeded significantly. For this reason, we have based our calculations on an estimate of this maximum superheat; that is, on a temperature difference of 40°C. Judging from the superheat encountered by a balloon made of neoprene-coated nylon flown by New York University in 1948[1], our estimate is a reasonable one. The balloon mentioned above developed a superheat of approximately 35°C. while floating at 35,000 ft. at 1700 local time in July.

[1] Research Division, College of Engineering, New York University, Technical Report No. 9302, Section 3, p. 39.

2. A second reason for using thicknesses of two to three mils, as we are doing, is the fact that the theory does not apply to the entire operation which we are trying to perform. In addition to containing the super-pressure developed by superheat, for simplicity of construction, we are attempting also to contain all of the free lift introduced at launching. If this can be done, there will be no need for a pressure relief valve, or other device to exhaust part of the free lift gas. From data so far obtained, it appears that it is possible to contain a reasonable amount of free lift.

3. A third reason for using thicker films is found in the fact that our main objective is to design and build a balloon which will give the desired performance -- to prove that such performance can be obtained. We wish to avoid all unnecessary risks to the successful attainment of this objective. If fragile materials were used, all flights would have additional handling hazards and, when decisions as to the success of a particular type must be made after a relatively small number of flights, it would be unwise to have failures which might be attributed to such incidental factors as handling. Once a balloon has been flown which accomplishes the objective, we shall have sufficient temperature and super-pressure data to determine any excess strength in the balloon, and at that time reduction of material thickness, etc. can be made if desirable.

B. Additional Points in Stress Analysis

Calculation of Stress in Onions

At the conference on May 11, Dr. Ney contributed some information bearing on the stress analysis of onion shaped balloons. (Photo #5707 shows an onion-shaped balloon).

1. Since the stress in the material must be the same all along one meridian, the calculation of stress at any convenient point determines the value which would be obtained if it were correctly calculated at more difficult points.

The radius of curvature of the onion-shaped balloon at its equator, that is, the radius of curvature of a meridian at that point, is one-half that for a sphere with a diameter equal to the equatorial diameter of the onion.

This relationship just offsets the effect of the concentrating of the stress in the meridional direction. For a given radius of curvature, the stress developed by an onion balloon would be twice that for the same radius of curvature in a sphere, due to the polarizing of the stress. But since an onion balloon of a given equatorial diameter has a radius of curvature meridionally (at its equator) of one-half of the magnitude of its equatorial radius, this doubling of stress does not occur. Therefore, a sphere and an onion of the same equatorial diameter will develop the same stress in their walls for a given super-pressure. The only differences will be:

a. The stress in the onion will be in only the two polar directions, while the stress in the sphere will be in all surface directions at any point.

b. The stress at a pole fitting in the onion can run very high, while in a sphere it will be the same as elsewhere in the balloon's wall.

2. The last point mentioned deserves special attention. The stress at a fitting in an onion balloon containing super-pressure is determined by the stress per lineal inch in the film, multiplied by the number of lineal inches in the circumference of the cylinder of material from which it is made. This stress can amount to several tons.

Stresses in Spheres with Internal Pressure

An additional safety factor appears to have been incorporated in our calculations of the stress to be encountered from internal pressure. According to Mark's Engineers' Handbook, page 451 of the 4th Edition, the true stress in a hollow sphere containing pressure is a function of Poisson's ratio for the material involved. A material with Poisson's ratio of 0.333, for example, has the true stress equation:

$$\text{True Stress} = T = \frac{Pr}{3t}$$

instead of

$$\text{Apparent Stress} = S = \frac{Pr}{2t}$$

which is the equation we have used.

The general equation is $T = S - \frac{S}{n}$

where n = the reciprocal of the applicable Poisson's ratio.

It is recognized that the plastic films will not have a Poisson's ratio of 0.333 (glass has 0.244), but whatever their values are, the characteristic involved here operates to our advantage.

Strain Calculation in the Design of Onions

In order to design properly for the exact dimensions of an onion balloon under stress, it is necessary that we take into account the stretching of the material along the meridional direction. This will affect the dimension built into the balloon by the spacing of the end fittings. Before this can be done with any accuracy, the stress-strain relationship at low temperatures will have to be determined. If this feature is not considered, the balloon's pole to pole dimension will be longer than that required by the equation $D = 0.764\ L$, and the purpose of the onion shape may be defeated by too small a D for the stretched L.

C. New Data on Low Temperature Tensile Properties of Materials

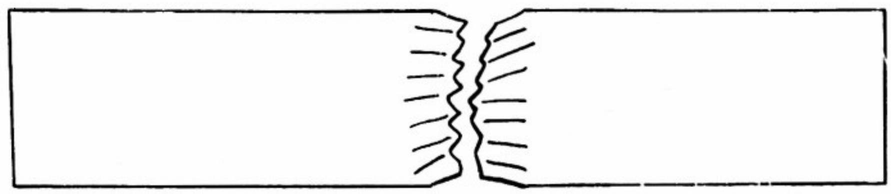
A portable cold box built to enclose the jaws of the tensile testing machine (see Photo nos. 7357 and 7361) was put through a trial run on May 5. At that time, the need for some minor modifications to make its operation smoother became apparent, but sufficient data were taken to provide us with critical information regarding the stress-strain properties of Saran, polyethylene and Mylar at stratospheric temperatures. After the first run, the box was removed for the final adjustments. These have been completed and the cold box re-installed on the tensile tester. An exhaustive study of the tensile properties of materials and seals at low temperatures is underway. A full report will be made when this study has been completed.

The data taken on May 5 reveal the following:

1. Mylar

a. The tensile strength of one mil Mylar appears to level off at approximately 28,000 lb./in.^{2} as the temperature decreases below -30°C. At -55°C. and at -65°C. this same value was obtained. The literature of E. I. duPont de Nemours & Co. on Mylar shows the tensile strength to reach 28,000 lb./in.^{2} at approximately -30°C.

b. Elongation and elasticity of the material under stress seem to be much improved at low temperature, however. No appreciable permanent elongation was experienced, and the only permanent distortion was in the vicinity of the break where both ends were shrunken laterally and the edges permanently set in waves, as in the following sketch.



c. The tensile modulus obtained at these low temperatures was 640,000 lb./in.^{2}

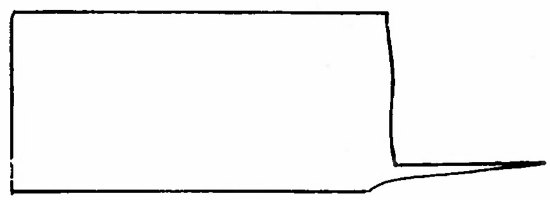
2. Saran

Data taken with 2.85 mil Q853.1 (unopened 1.5 mil tubing) can best be presented in table form.

Table I

Temperature (°C.)	Strength Transverse (lb./in.^{2})	Strength Longitudinal (lb./in.^{2})	Elastic Modulus Transverse (lb./in.^{2})	Elastic Modulus Longitudinal (lb./in.^{2})
-55	21,000	23,700	954,000	655,000
-60	15,800	20,200	1,180,000	757,000
-70	25,000	-	772,000	-

The breaks at -55°C. were smooth, but at -60°C. and below there were characteristics which suggested cold brittleness. Sharp angles in the tear, a saw-tooth edge, and one with an edge as sketched below were produced at the lower temperatures.



The most significant discovery about the general performance of Saran was that in all cases there was no permanent deformation, no permanent elongation of the film. After the break, the two pieces of the specimen were brought end-to-end again and measured. Apparently, after applying anything less than the stresses shown above, the material would be within its elastic limit and would return to its original dimension once the stress was removed. This is of fundamental importance in the functioning of the super-pressure balloon.

Whether or not the decrease in strength from -55°C. to -60°C., and the increase again at -70°C., are real will be determined by the comprehensive study now underway.

Saran A517 was also tested on May 5. Strengths of 24,000 lb./in.^{2} and 25,000 lb./in.^{2} were measured at -40°C. and -55°C. respectively, with an average elastic modulus of 800,000 lb./in.^{2}, but even at -40°C. there were evidences of cold brittleness. Again, there was no permanent elongation. A thickness of 2 mils was used (unopened 1 mil tubing).

3. Polyethylene

Polyethylene was found to have a strength of 6700 lb./in.^{2} and a tensile modulus of 195,000 lb./in.^{2} at -70°C. A thickness of 4 mils was used in this test (unopened 2 mil tubing). In another test, 2 mil material showed a strength of 6250 lb./in.^{2} at -55°C. and a tensile modulus of 234,000 lb./in.^{2}. With the polyethylene, there was permanent elongation of approximately 20%, so these figures do not refer to elastic material, as they do in the case of Saran.

Further data on the characteristics of polyethylene heat seals as a function of temperature are found in Drawings A-16124-A and A-16125-A in the Appendix.

II. BALLOON CONSTRUCTION

A. Saran

At the present time, onion balloons of Q853.1 and A517 Saran are being fabricated by Brown and Bigelow at our request. By contracting to have this done with their 48 inch electronic bar sealer, we are able to obtain balloons for laboratory and flight tests at an earlier date than would be possible if we were to wait for the completion of our own mobile electronic sealer. Design and development work on the latter is going ahead. When it has been completed, it will be possible to make spherical as well as onion-shaped balloons of Saran.

In connection with the balloon manufacture at Brown and Bigelow, where lap seals are being used for all but the last seal in each balloon, a comparison of seal strengths for three types of seals was made. These tests were at room temperature and indicate only the relative strengths to be expected from the three types of seals. Tests at lower temperatures will be made later. The material used was an unopened tube of 1.2 mil A517 Saran, and the seals were made with an electronic bar producing a seal 0.15 inches wide. Data are reported in Table II.

Table II

	Fin (lb./in.)	Modified Fin (lb./in.)	Lap (lb./in.)
	1.4	10.9	18.6
	0.8	10.7	19.1
	1.3	12.8	17.7
		12.2	
		12.5	
Average	1.2	11.8	18.5

B. Polyethylene-on-Mylar

One onion balloon of this material has been made (with polyethylene seal) from the first sample of the material, converted by the Dobeckmun Co.[1] On the basis of this successful fabrication of a balloon from polyethylene-on-Mylar, three hundred pounds of it have been ordered from the Dobeckmun Co. to make additional balloons for laboratory and flight tests. Use of this material is limited to the onion-shaped balloon, since only the polyethylene is sealed. The material is due to arrive by the middle of June.

C. Polyethylene-on-Saran

The report on polyethylene-on-Saran which was made in our letter of April 27 was in error. Dobeckmun is not certain that such a combination would be successful. We are advised that they will be glad to go ahead on a "best effort" basis in which we would bear the expense, estimated to be between $200 and $500, regardless of the degree of success in bonding the two materials.

We have advised them that, until Saran by itself has been proved to be inadequate, we feel that such an experiment is not warranted.

The reason for investigating the polyethylene-Saran combination was to improve the cold brittleness and tear characteristics of Saran. Since polyethylene would make an electronic seal impossible, the seals would necessarily be heat seals of the polyethylene alone, as in the case of the polyethylene on Mylar. The onion shape or, in general, the type of balloon with no circumferential stress, would be the only application for this material.

D. Polyethylene Impregnated Fiberglas

Dobeckmun Company has not as yet developed a production technique for impregnating fiberglas of the weight we need with polyethylene. They have produced some samples which we are testing, but the density of the weave has so far prevented them from obtaining the penetration which was possible with the more loosely woven scrim.

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[1] The flight made with this balloon is reported in III, Experiments Executed.

III. EXPERIMENTS EXECUTED

A. Laboratory

1. The tensile properties of Saran, Mylar and polyethylene at low temperature were investigated during the first run of the equipment pictured in Photographs No. 7357 and 7361, which show the cold box installed on the tensile tester. Data from these tests are reported on pages 5 - 7. A more complete study of the variation of tensile characteristics of materials and seals as a function of temperature is being pursued.

The cold box uses dry ice in a wire basket suspended on its left wall inside. The air is circulated by a fan driven by a sewing machine motor (visible) which is controlled by the rheostat shown on the front of the cabinet.

2. A comparison of the strengths of three types of seal, all made with the same electronic bar sealer, was accomplished. Data from this test, which was run at room temperature, are shown in Table II on page 7.

3. Inflation tests of the nylon spheres were made using 500 gram and 800 gram Neoprene balloons as bladders. The inflated spheres are seen in photographs numbered 7177, 7178, 7180, and 7181. During these tests it was learned that friction between the nylon and the rubber sometimes prevented the rubber balloon from expanding uniformly. It also built up a very high charge of static electricity which made handling difficult and impeded the withdrawal of the rubber bladder.

B. Flight

1. Flight No. 1126. This was the first test of the nylon envelope enclosing a polyethylene bladder (see Drawing A-21283-B). The balloon failed to reach floating altitude. Whether this was due to the fact that it was launched at night with only 6.5% free lift and was prevented from rising by an inversion or whether it encountered the decrease of lift reported by Dr. Ney, or whether it descended due to leaks is not certain. The polyethylene liner was later ammonia-tested for leaks, and a large number of widely scattered small holes were found in addition to the larger ones caused by rough handling during recovery. It is possible that these were caused by the strong discharges of static electricity which were observed during inflation when the lights were turned off. Some of these lightening-like flashes were over a foot long.

Photo no. 7232 shows the balloon immediately before launching.

2. Flight No. 1127. As a result of the failure of Flight No. 1126, which may have been due to night-time conditions, this flight, with a polyethylene-on-Mylar balloon, was launched in the afternoon approximately 2.5 hours before sunset on the balloon (see Drawing No. A-21285-B). The purpose was to determine the amount of super-pressure developed by superheat plus 7% free lift on this type of balloon. At the same time, the rate of rise of an onion-shaped balloon with 7% free lift would be determined.

The rate of rise experienced was 478 ft./min., but when the pressure commenced to build up within the balloon as it approached altitude, the balloon burst and descended at a rate of 1370 ft./min. to the ground. When recovered, it was found to be split from near the top fitting to near the bottom fitting along one gore. The split was in the material at each end, but within a few feet it joined a seam and travelled along the seam to within a few feet of the other fitting where it propagated out into the gore again.

Pressure was developed before the balloon reached its theoretical ceiling due to the fact that, in order for the balloon to acquire its true shape, the lower fitting must be raised by the expanding balloon until it is within 10.5 ft. of the top fitting. This will be accomplished only through the pressurization of the balloon. The load is attached directly to the bottom fitting and must be raised with it. Since the total tension in the film at the fitting is expected to be several tons, the load of 10.5 lbs. should not have any significant effect upon the shape which is finally realized, but design volume is not attained until it is raised.

A third objective of the flight, which was not accomplished, was to observe the performance as the balloon passed through the sunset period and into the night. Flight termination, by severing the pressure line to the telemeter, was set for 6 hours.

3. Flight No. 1128. The second flight test of a nylon envelope containing a polyethylene bladder was launched at 1611 CST to avoid any trouble from night effects upon lift. The disadvantage of a day-time launching is that the flight does not provide an indication of the amount of super-pressure which is developed by the free lift alone, as it would if launched at night.

It is true that, from Dr. Ney's experiments, it is evident that the earth's radiation causes an increase in lift in the vicinity of 50,000 ft., and that at other levels the night-time equilibrium condition may be such that lift is actually lost, and hence that there would be factors in addition to free lift involved in the super-pressure even for night-time launchings. However, whatever the earth's effects, they are present day and night, and they are a part of the equilibrium situation during the day. Super-pressure in a balloon at a given altitude at night, if its free lift has been contained, would be a significant value to relate to free lift, rate of rise, stress, etc.

With 3% free lift (1 lb.), Flight 1128 rose at a rate of 343 ft./min. to its pressure altitude where, like Flight 1127, it burst after developing only slightly more than one inch of water super-pressure.

Upon examination of the balloon in the laboratory after the flight, it was found that the nylon envelope was in perfect condition. The polyethylene liner had split from the crown downward on two opposite meridians half way to its other pole, leaving the top half of the balloon in two approximately equal sections. The crown of the balloon, where the tear apparently started, was shredded into a most extreme example of a cold brittleness type of rupture.

In discussing this apparent cold brittleness condition in polyethylene with Dr. L. W. Sheridan, it was learned that he has encountered in his material testing work some indications that, when under tensile stress, polyethylene's cold brittleness temperature is not as low as otherwise. After testing three of four samples cut from the same strip of material and finding the three to be non-brittle at -68°C., he deliberately stretched the fourth specimen while fastening it into the hoop. It showed the characteristic cold brittleness type of rupture when struck by the steel ball at -68°C. This is the only explanation so far offered for the shattering of the polyethylene liner enclosed in a nylon cover under the bright sunlight at 37,000 ft.

The same nylon envelope is to be tested in the laboratory with the same type of polyethylene liner to see what can be learned of the stresses developed.

IV. EXPERIMENTS PLANNED

A. Laboratory

1. A comprehensive study of tensile characteristics of films and seals at low temperature.

2. A study of comparative superheat in the exact materials being used in the balloons which have grown out of this project. This experiment will be conducted with an infrared lamp using the technique described in Report No. 1289.

3. Static inflation tests of the three types of balloons already produced.

   a. Polyethylene bladder in nylon cover.
   b. Saran onion.
   c. Polyethylene-on-Mylar onion.

When the spherical Saran balloon can be produced, that is, when the mobile electronic sealer has been completed, it too will be static tested, of course. In order to duplicate as closely as possible the stress conditions aloft, the balloons will first be inflated with helium until buoyant equilibrium is reached, and then nitrogen or air will be added to complete the inflation and to build up the super-pressure, which will be measured. If helium were used alone, approximately 100 pounds of lift would be attained at full inflation. This would create lifting stresses at the point where the balloon was held down, which would not be a true picture of the balloon under flight conditions.

The fittings being used in the onion balloons are shown in photos numbered 7333 and 7334 as they appear in the end of a Saran balloon. Drawings for these fittings are numbered A-15800-B through A-15803-B inclusive and are also found in the Appendix.

B. Flight

1. Temperature telemetering (in addition to altitude) to obtain the difference between lifting gas and ambient will be made on each type of balloon as described in Report No. 1289. The telemeter is shown in Photo No. 7496, and the electrical circuit in Drawing A-16088-B.

2. Pressure telemetering (in addition to altitude) will be accomplished with each type of balloon to obtain a measure of the super-pressure throughout the flight. Photo no. 7234 shows the telemeter which is described in further detail in the Appendix.

3. It has been decided that a line connecting the two fittings in the onion-shaped balloons will not be used as was indicated in letter report dated 27 April 1954 for reasons given in report of Flight 1126.

4. Stockpiling of balloons and telemetering equipment for a series of ten to twelve flights should be complete by the end of June. If the present poor trajectory situation is still dominant, the balloons will then be flown from some other site on a field trip. If these flights are not successful, it is hoped that sufficient data will be obtained to indicate the necessary modifications. A later series of flights may then be planned, which should include some made with spherical Saran balloons made possible by the development of the mobile electronic sealer.

V. FINANCES

The total of funds committed as of 31 May 1954 was $18,720. Of this amount, $13,221 was labor and burden.

It is expected that the next two months will require somewhat greater expenditure than in the months so far, which have been low on a pro rata basis.

APPENDIX

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SUPER-PRESSURE TELEMETERING SYSTEM

A Combined Telemetering Unit for Ambient Pressure and Internal Pressure for Use on Small Super-pressure Balloons

The device uses two separate transducers which mount on a code drum assembly. Data are transmitted alternately from the two transducers.

Transmitter

The transmitter is a converted 40.54 megacycle radiosonde unit. It is described in Report No. 1167. The keying circuit is arranged as described in this report except a resistor is placed in series with one of the transducers in order to lengthen the time constant. This causes a difference in pitch between the two code groups making it easy to distinguish between the ambient pressure signal and the internal pressure signal.

Ambient Pressure Transducer

The code drum assembly with both pressure capsules is shown on photograph no. 6997. The ambient pressure transducer consists of an 'A' frame assembly from a standard radiosonde. Any of a variety of bellows and contact arm assemblies could be used for this purpose. This assembly is mounted on an insulating fiber plate instead of being mounted directly on the metal frame of the code drum assembly. The connection is made through a resistor of sufficient size to give a modulating note noticeably lower than that of the other transducer, which is mounted directly on the metal frame.

Internal Pressure Transducer

The frame for this assembly is cut from 24 ST aluminum 3/8" thick. The pressure capsule is a Kollsman type SK901 bellows with a small hole drilled axially through its mounting bolt in order that pressure may be applied internally. A brass fitting is wound over the mounting bolt. The connecting tube from the balloon connects to the fitting causing the bellows to respond to the internal pressure of the balloon. The contact arm and pivot were obtained from a radiosonde unit. The linkage is adjusted to give full-scale deflection at the desired pressure. The unit in the photograph is adjusted to give full-scale deflection at a pressure of 30 inches of water.

Code Drum and Drive

The code drum is conductive only on the code groups themselves. There is no long dash as is the case on the standard drum. The motor is a 5 RPM Brailsford. A fixed brush makes contact on the edge of the drum opposite the motor. This is the "hot" keying lead to the transmitter. The ground of the transmitter is common to the frame of the transducer assembly.

The complete telemetering unit including transmitter, transducers, code drum, and battery supply is shown on photograph no. 7234.

D. A. Church
1 June 1954

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DRAWINGS

A-15227-B	Curves showing flight duration necessary for various distances of travel as a function of wind speed at floating level. For flights of less than 400 miles, another set of curves will be drawn in which the rate of rise is considered, when applicable rates of rise are known.
A-15671-B A-15672-B	Fittings used in the base of the spherical polyethylene-nylon fabric balloon.
A-15800-B A-15801-B A-15802-B A-15803-B	Fittings used in both ends of the onion balloons, A-15800-B being used in place of an ordinary bolt in the fitting at the base of the balloon (see photos 7333 and 7334).
A-16088-B	Wiring diagram for the temperature telemetering system. (See photo 7496.)
A-16124-A A-16125-A	Curves showing the variation of the tensile characteristics of polyethylene heat seals as a function of temperature.
A-21283-B A-21285-B A-21287-B	Time/Altitude and super-pressure curves for Flight 1126. Time/Altitude and super-pressure curves for Flight 1127. Time/Altitude and super-pressure curves for Flight 1128.

PHOTOGRAPHS

5707	Polyethylene onion-shaped balloon.
7177 7178 7180 7181	Inflation test of 15 ft. nylon sphere using air in Neoprene bladder.
7232	Flight 1126 immediately before launching.
7234 6997	Instrument for 40 megacycle telemetering of both ambient pressure (for altitude) and super-pressure within the balloon.
7333 7334	End fittings in Saran onion balloon (see Drawings A-15800-B through A-15803-B).
7357 7361	Cold box installed on Tensile Tester.
7496	Instrument for 40 megacycle telemetering of ambient pressure (for altitude) and four temperatures. The coiled leads are for attachment of thermistors.
7566 7567 7568 7569	Fabrication of Saran cylinders at Brown & Bigelow.

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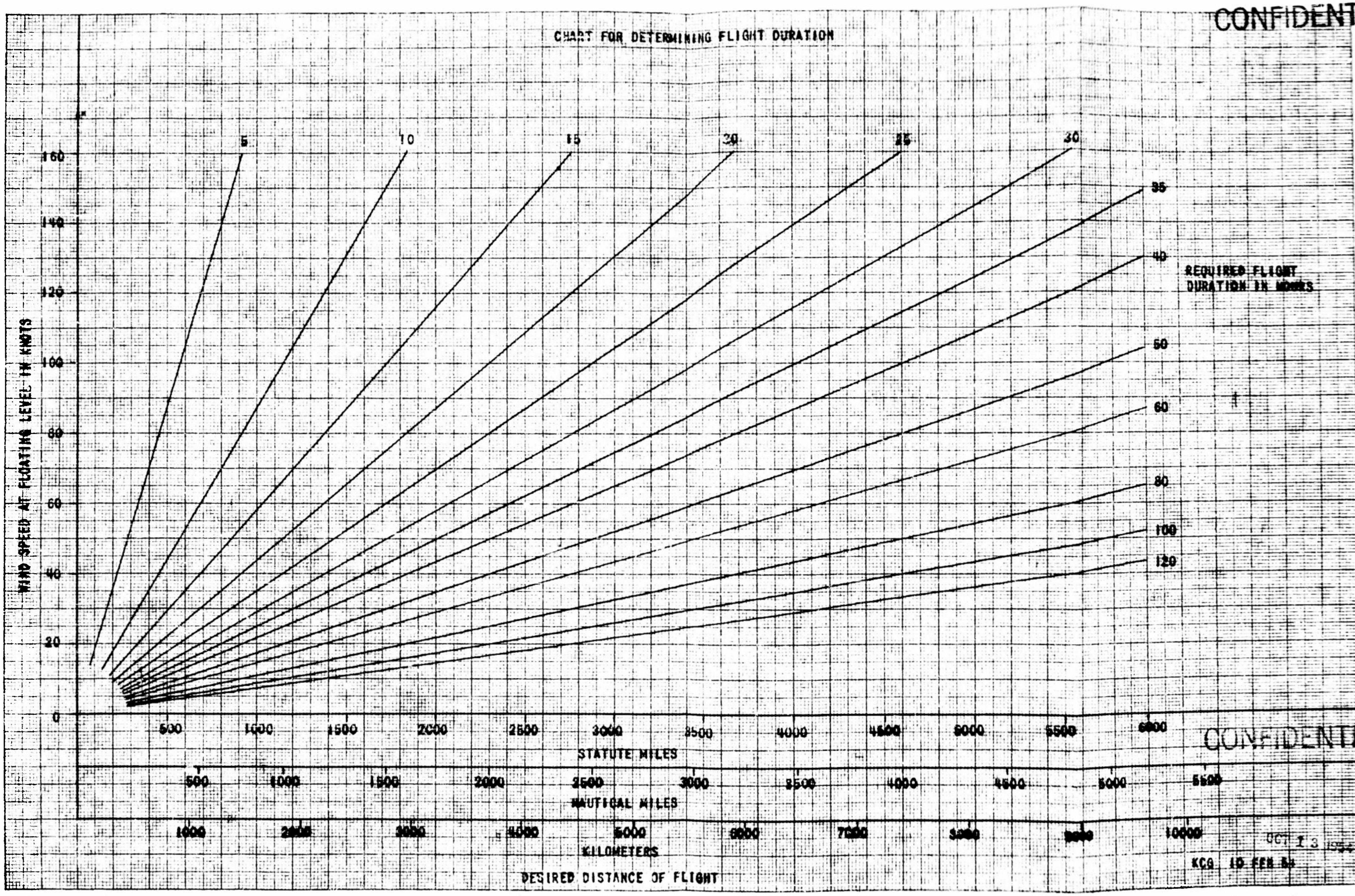

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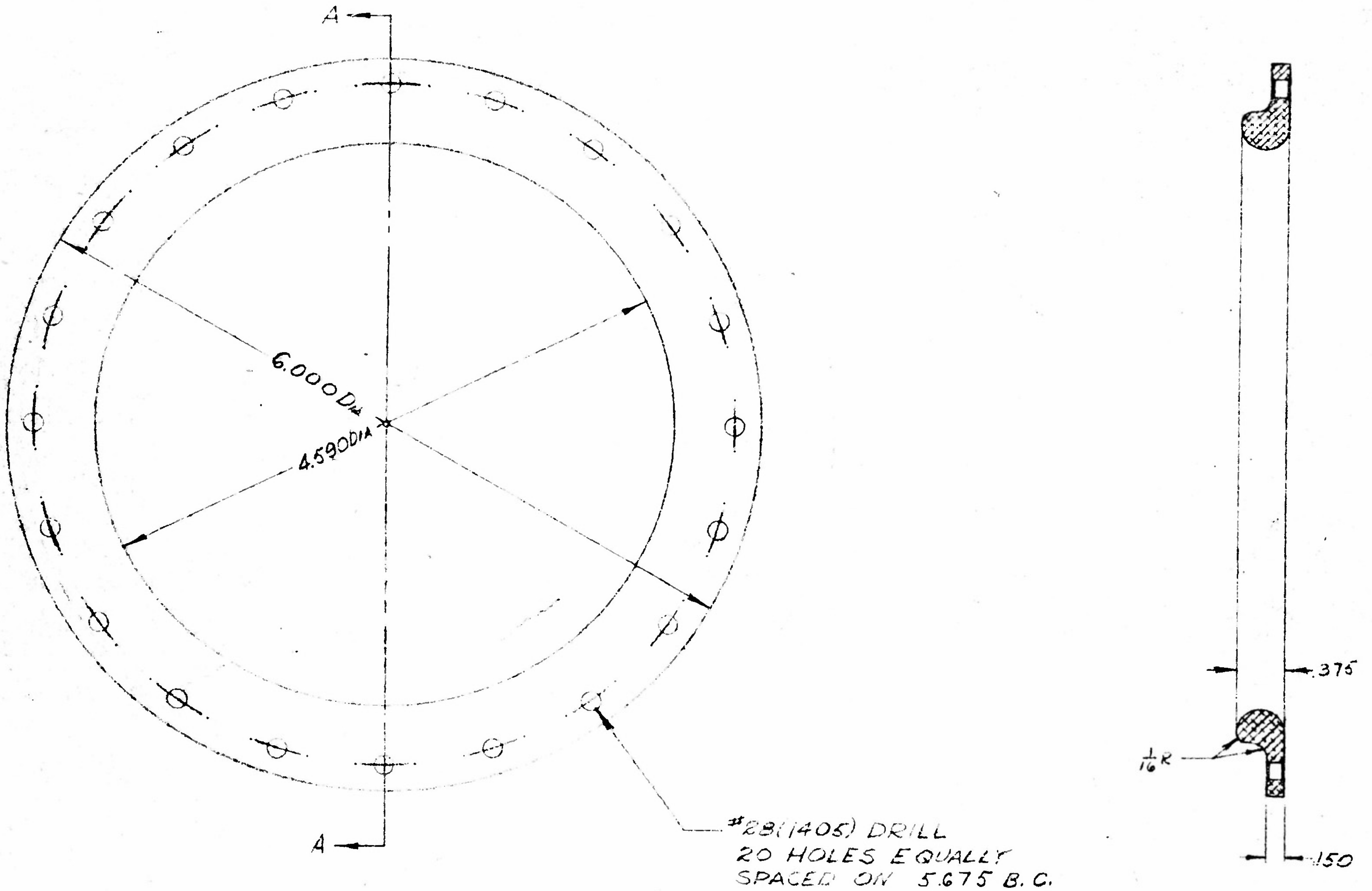

SECTION "A-A"

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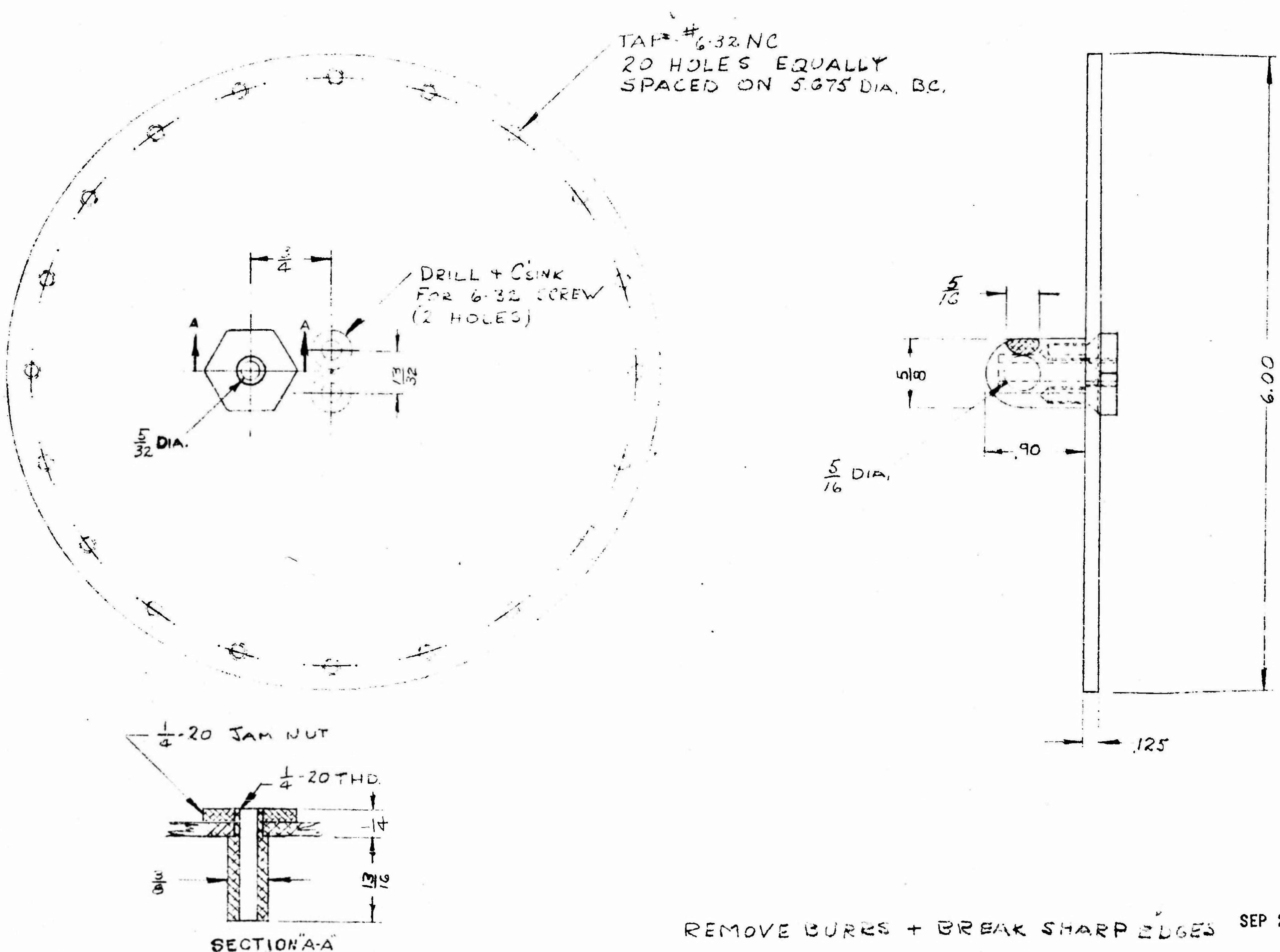


CONFIDENTIAL

REMOVE BURRS + BREAK SHARP EDGES

SEP 28 1954

EXCEPT AS NOTED
ALL TOLERANCES ± .030
GENERAL MILLS AERONAUTICAL RESEARCH LABORATORIES MACHINING SPECIFICATIONS APPLY

MAT'L. SPEC. ALUM	
DR. RBW	APP.
CH.	APP.
DATE 4-8-54	SCALE FULL
NAME APPENDIX PLATE	

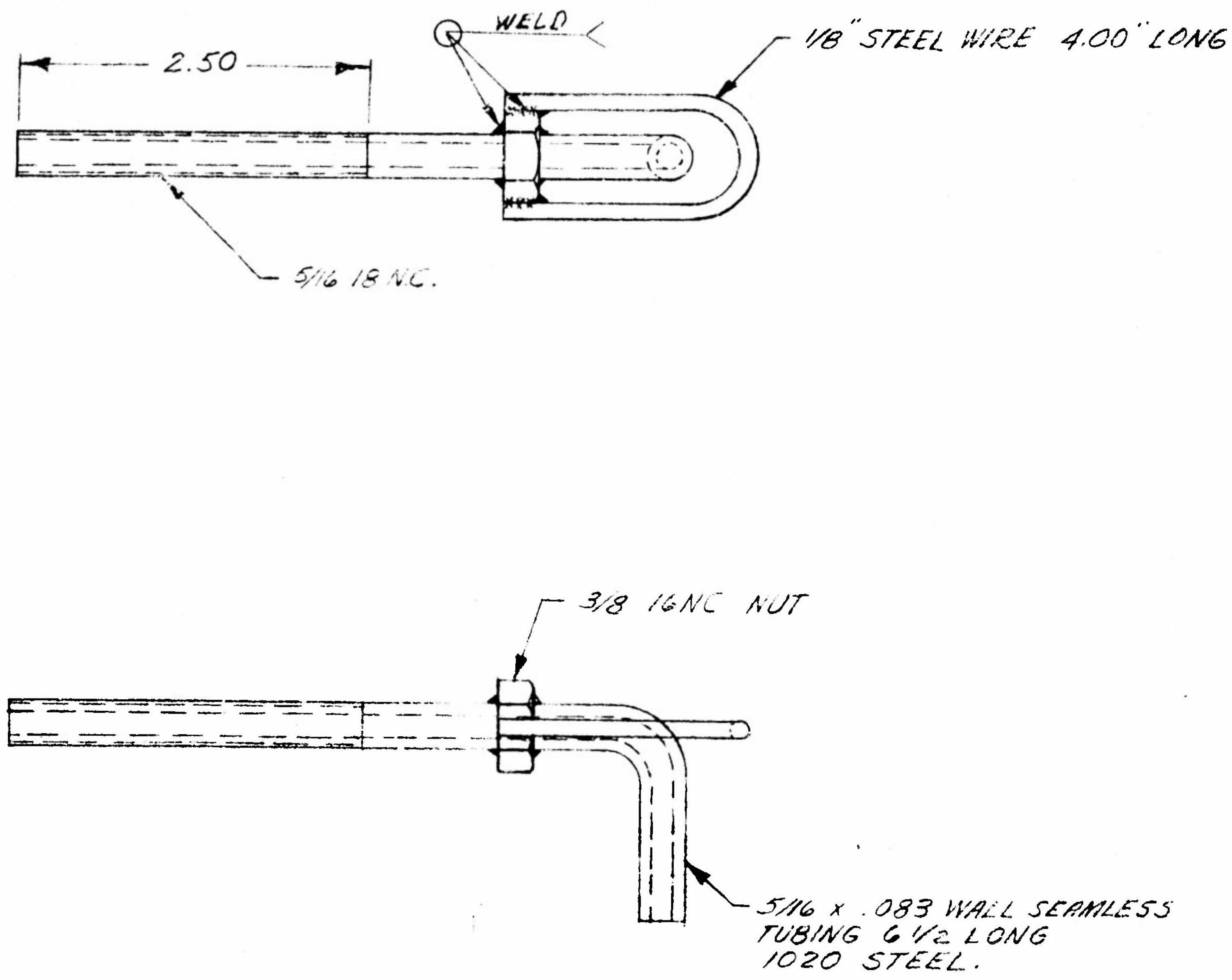
A-15672-B

GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.

ASS'Y. DWGS.

REVISIONS

CONFIDENTIAL



CONFIDENTIAL

EXCEPT AS NOTED
ALL TOLERANCES ± .030
GENERAL MILLS AERONAUTICAL RESEARCH LABORATORIES MACHINING SPECIFICATIONS APPLY

MAT'L. SPEC. NOTED

DR. RDS.	APP.
CH.	APP.
DATE 4-22-54	SCALE FULL

NAME INFLATION BOLT

A-15800-B

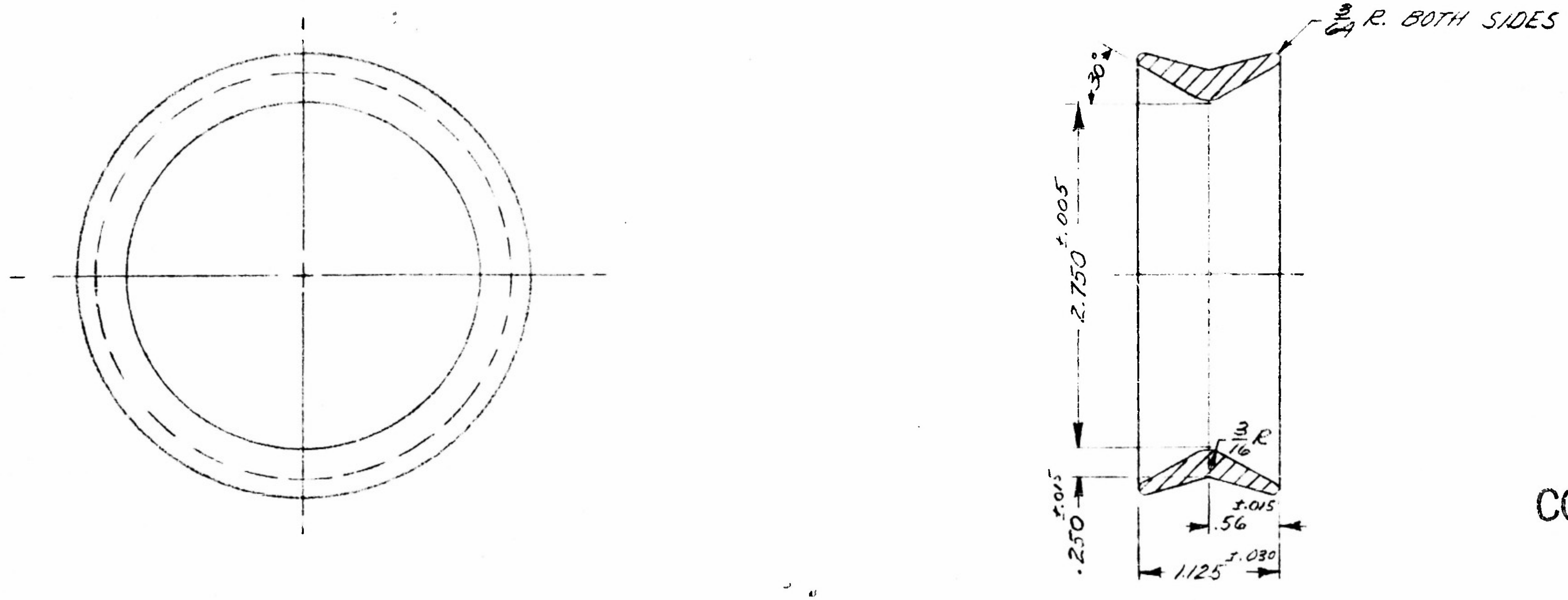
SEP 28 1954

GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.

ASSY. DWGS.

REVISIONS

CONFIDENTIAL



CONFIDENTIAL

EXCEPT AS NOTED ALL TOLERANCES ± .030 GENERAL MILLS AERONAUTICAL RESEARCH LABORATORIES MACHINING SPECIFICATIONS APPLY	
MAT'L. SPEC. ALUM. 24-ST. STOCK SIZE 3.56 DIA x 1.125 THICK	
DR. R.D.S.	APP.
CH.	APP.
DATE 9-21-54	SCALE FULL
NAME COLLAR	
A-15801-B	

SEP 28 1954

GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.

ASS'Y. DWGS.

REVISIONS

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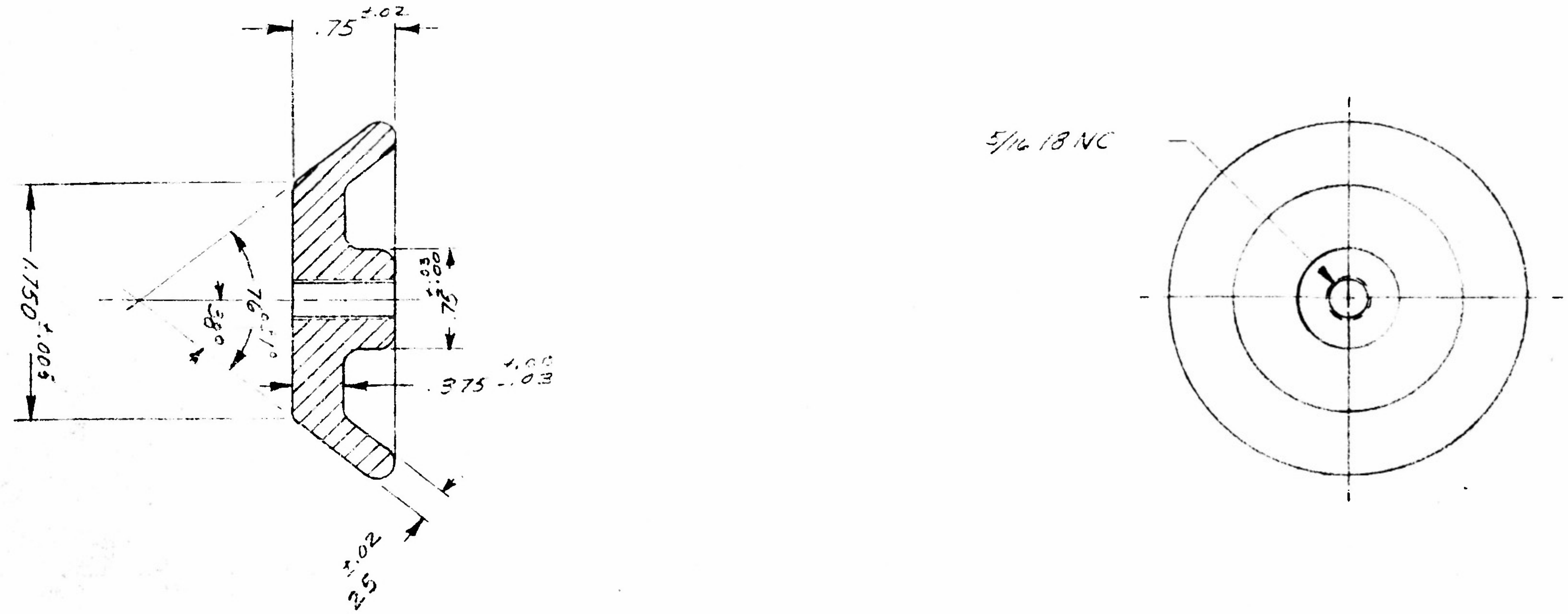


NOTE:

1. ALL RADII 1/8

CONFIDENTIAL

SEP 28 1954

EXCEPT AS NOTED ALL TOLERANCES ± .030
GENERAL MILLS AERONAUTICAL RESEARCH LABORATORIES MACHINING SPECIFICATIONS APPLY

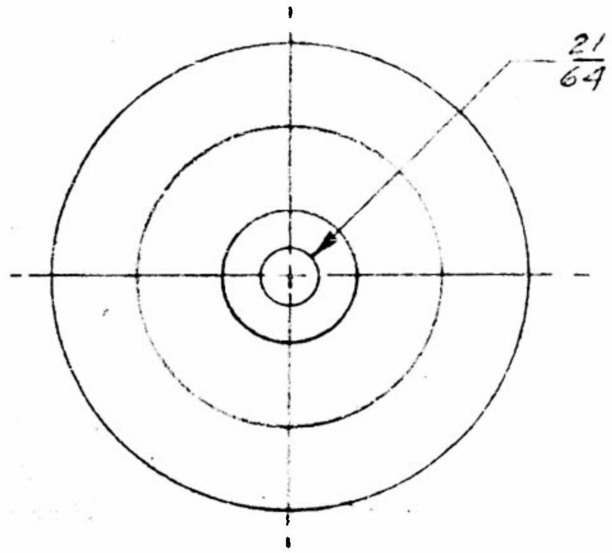
MAT'L. SPEC. ALUM. 24ST STOCK SIZE 2.75 DIA. x .75 STOCK	
DR. R.D.S.	APP.
CH.	APP.
DATE 4-21-54	SCALE FULL
NAME INSIDE WEDGE	
A-15802-B	

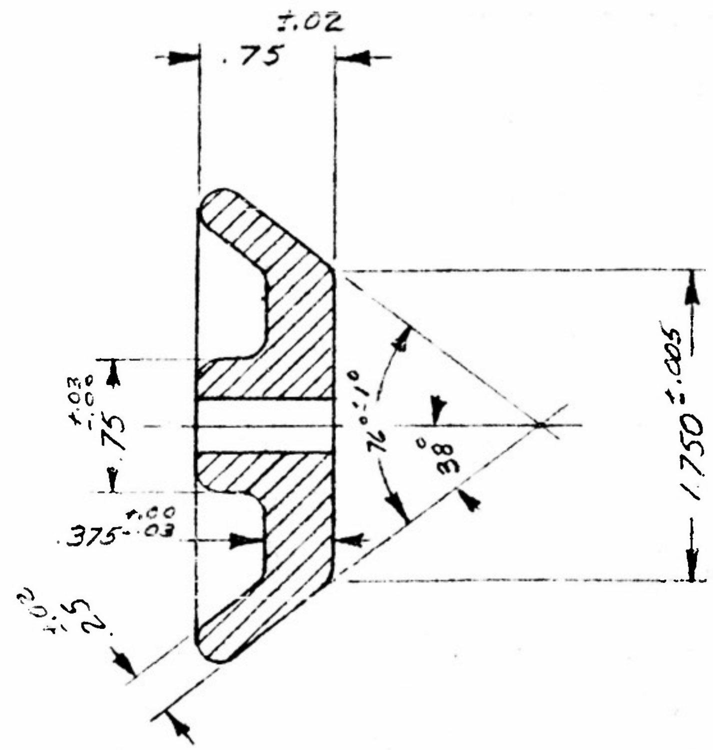
GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.

ASS'Y. DWGS.

REVISIONS

CONFIDENTIAL





CONFIDENTIAL

NOTE:
1. ALL RADII 1/8

SEP 28 1954

EXCEPT AS NOTED ALL TOLERANCES ± .030 GENERAL MILLS AERONAUTICAL RESEARCH LABORATORIES MACHINING SPECIFICATIONS APPLY	
MAT'L. SPEC. ALUM. 24ST STOCK SIZE 2.75 DIA × .75 THICK	
DR. R.D.S.	APP.
CH.	APP.
DATE 4-21-54	SCALE FULL
NAME OUTSIDE WEDGE	
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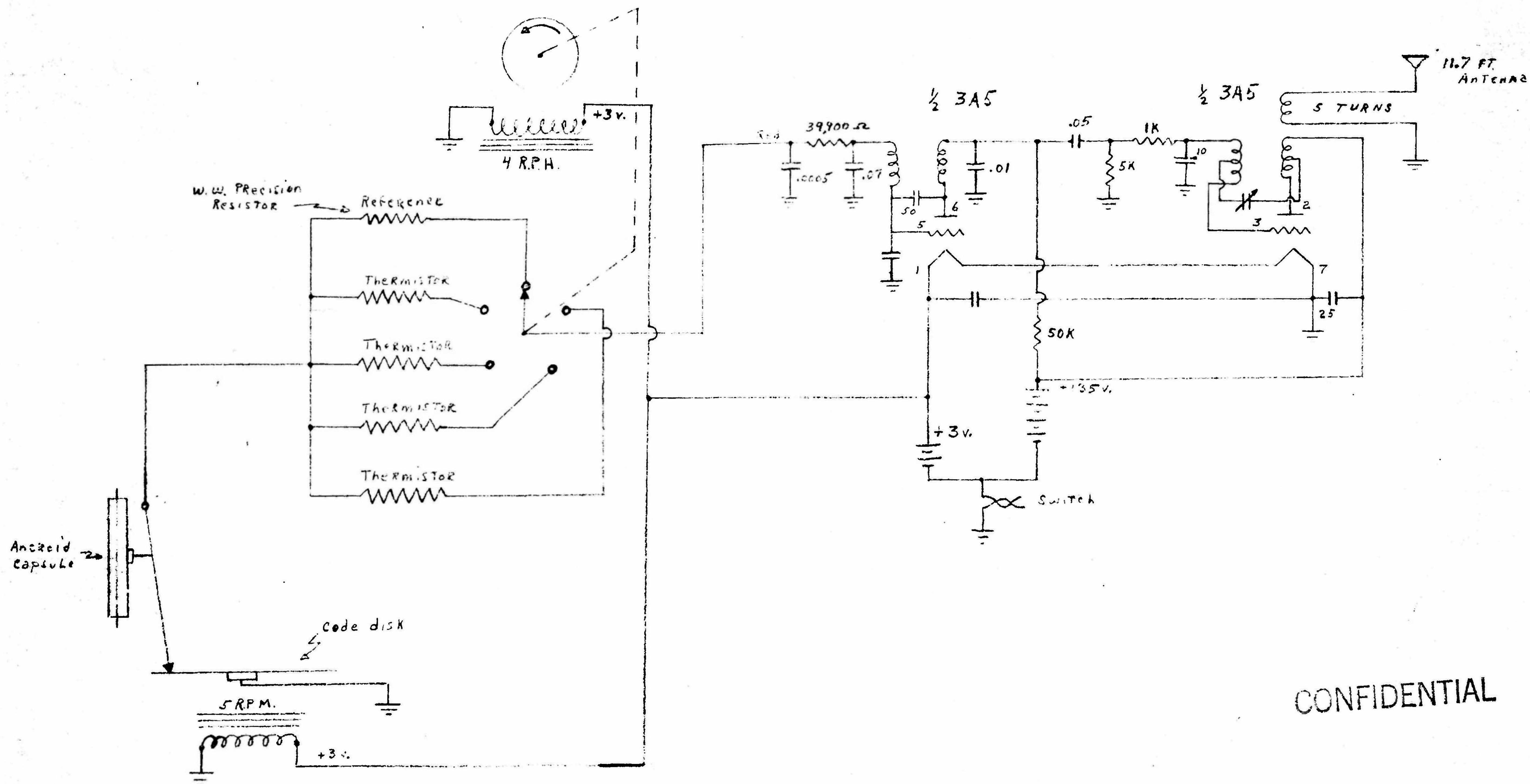
GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.

CONFIDENTIAL



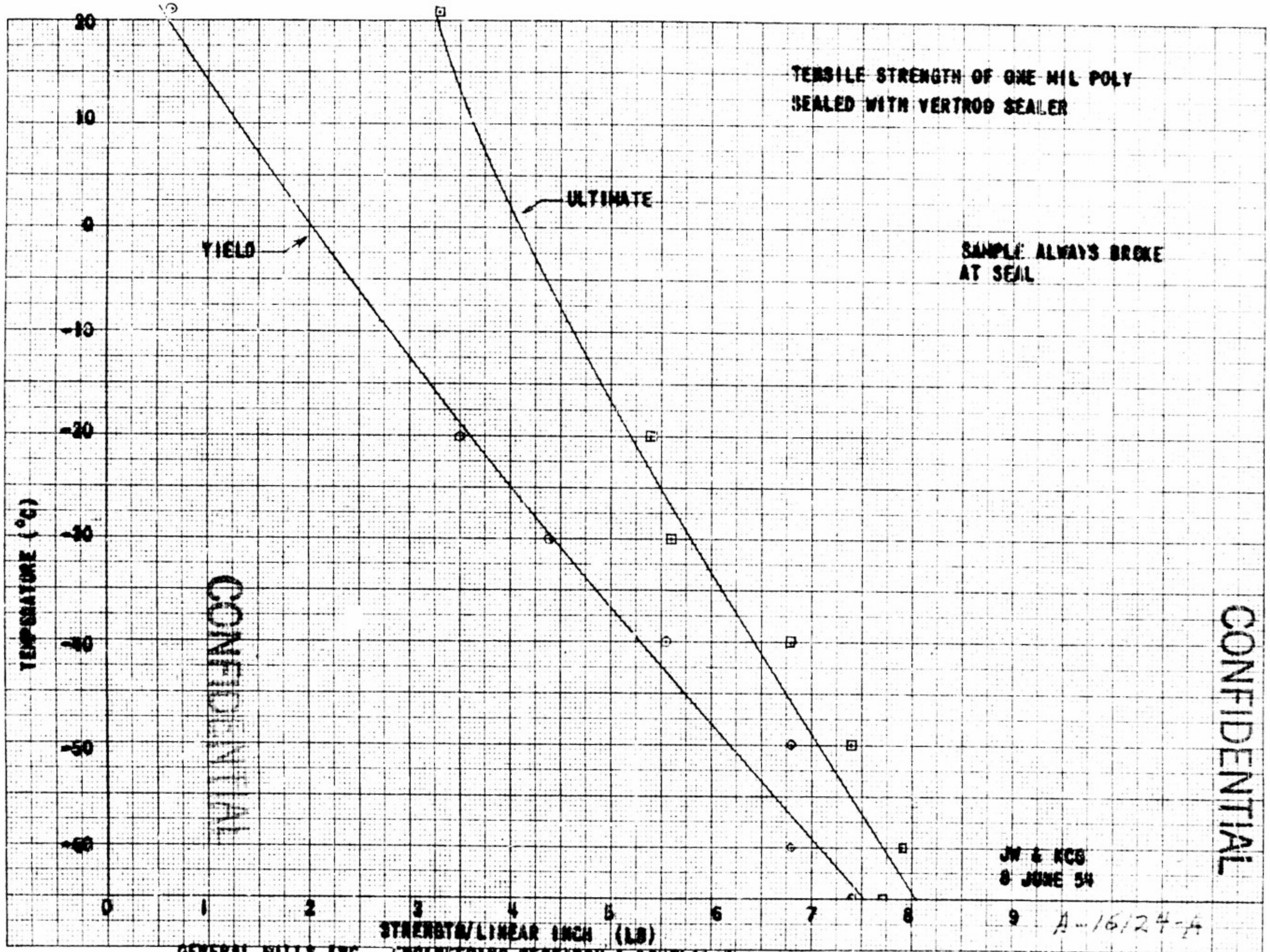
CONFIDENTIAL

Temperature Telemeter Transmitter - 85024

SEP 28 1954

A-16088-B

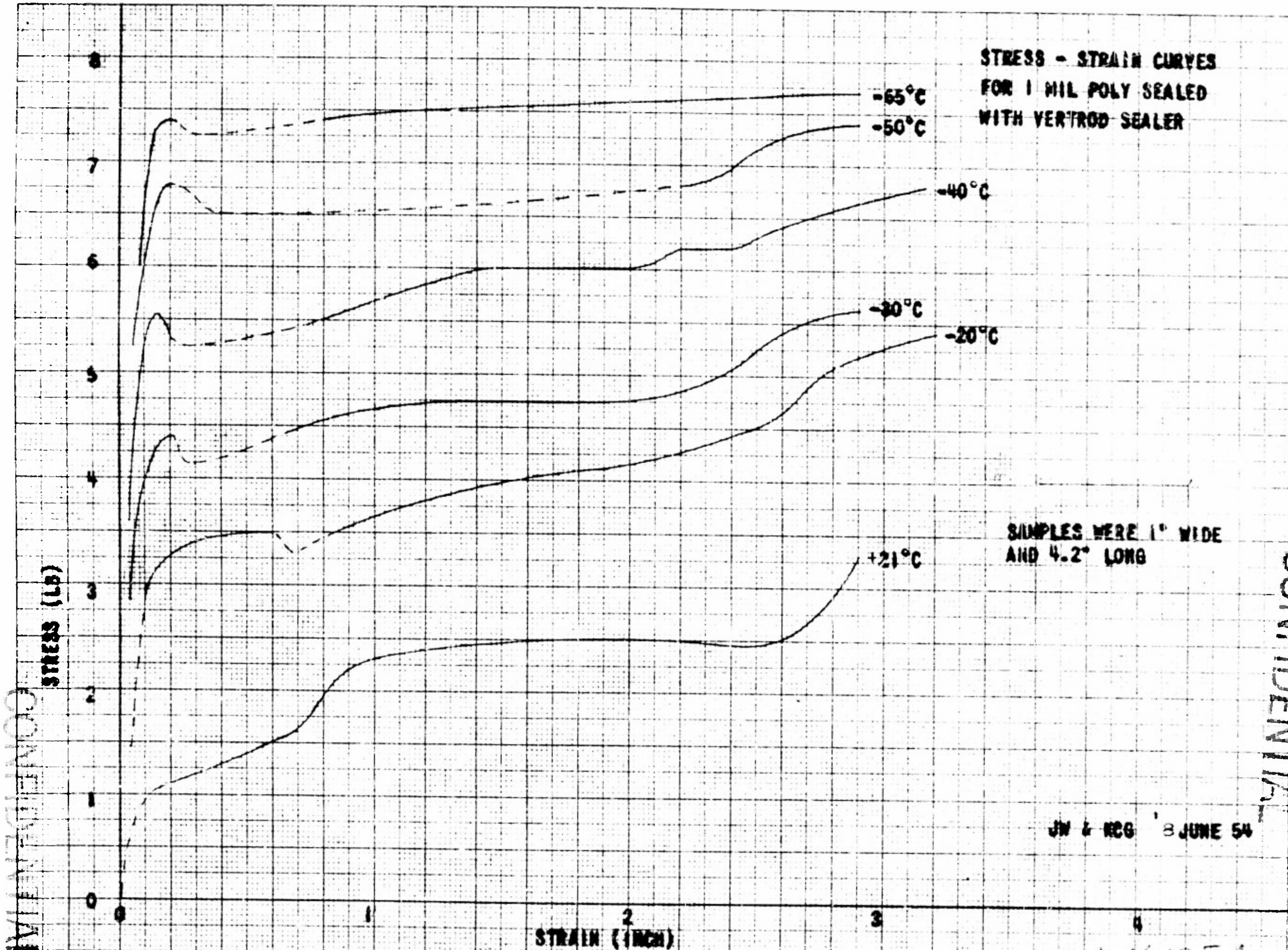
GENERAL MILLS, INC. AERONAUTICAL RESEARCH LABORATORY MINNEAPOLIS, MINN.



GENERAL MILLS INC., ENGINEERING RESEARCH & DEVELOPMENT DEPT., MINNEAPOLIS, MINN.

A-16124-A

SEP 28 1954



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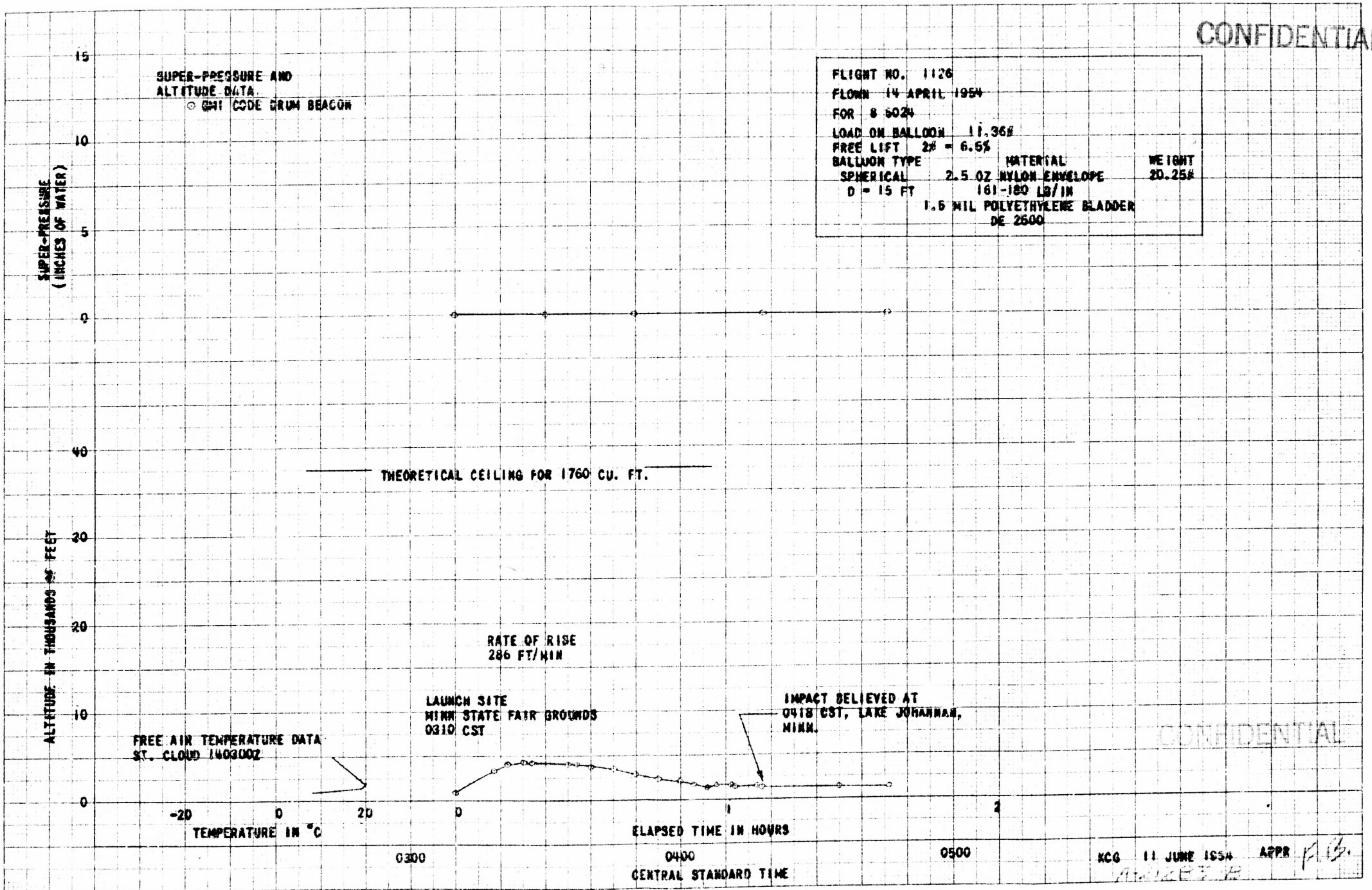
A-16425-A

SEP 2 8 1954



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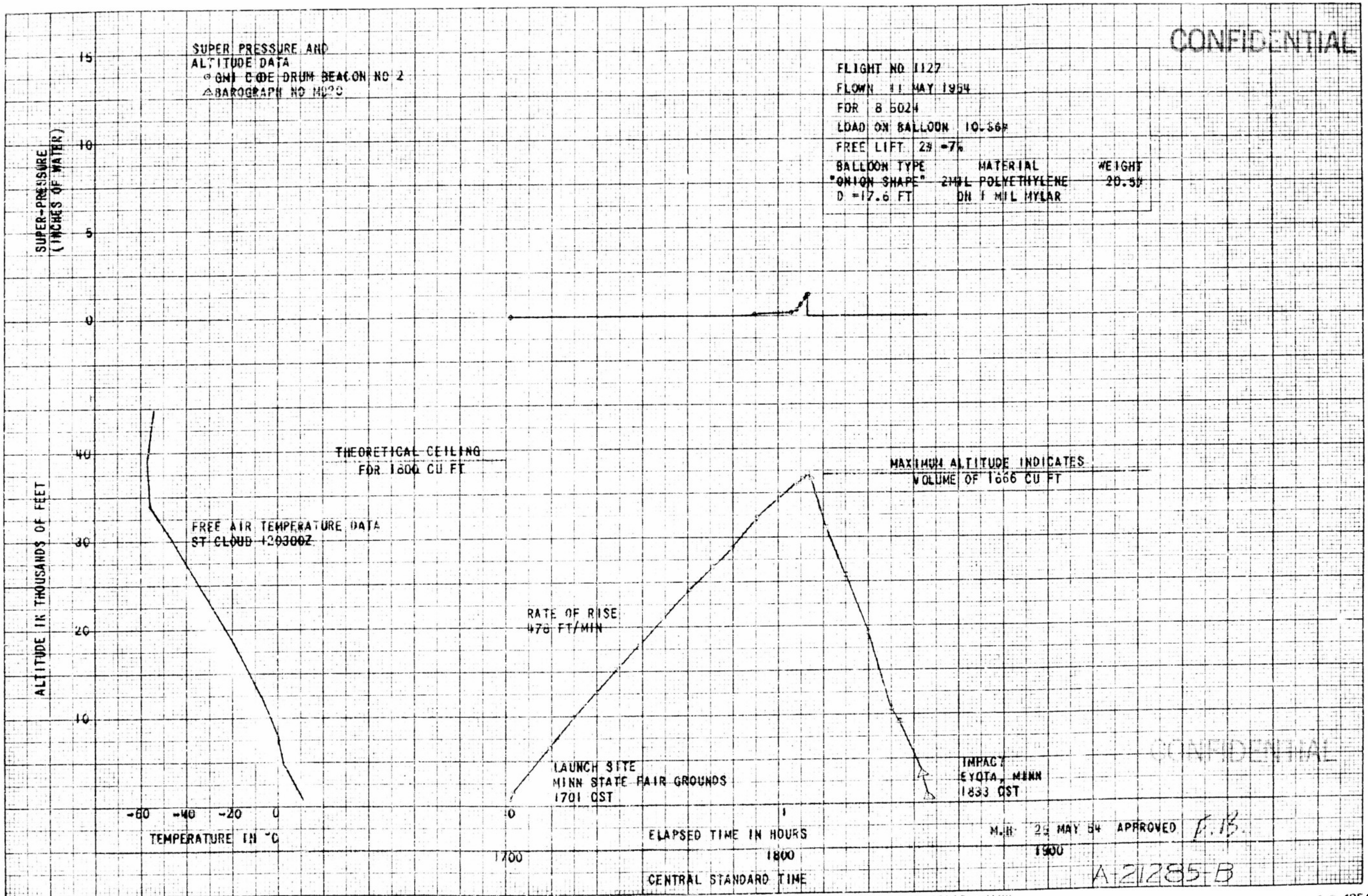
SEP 28 1954

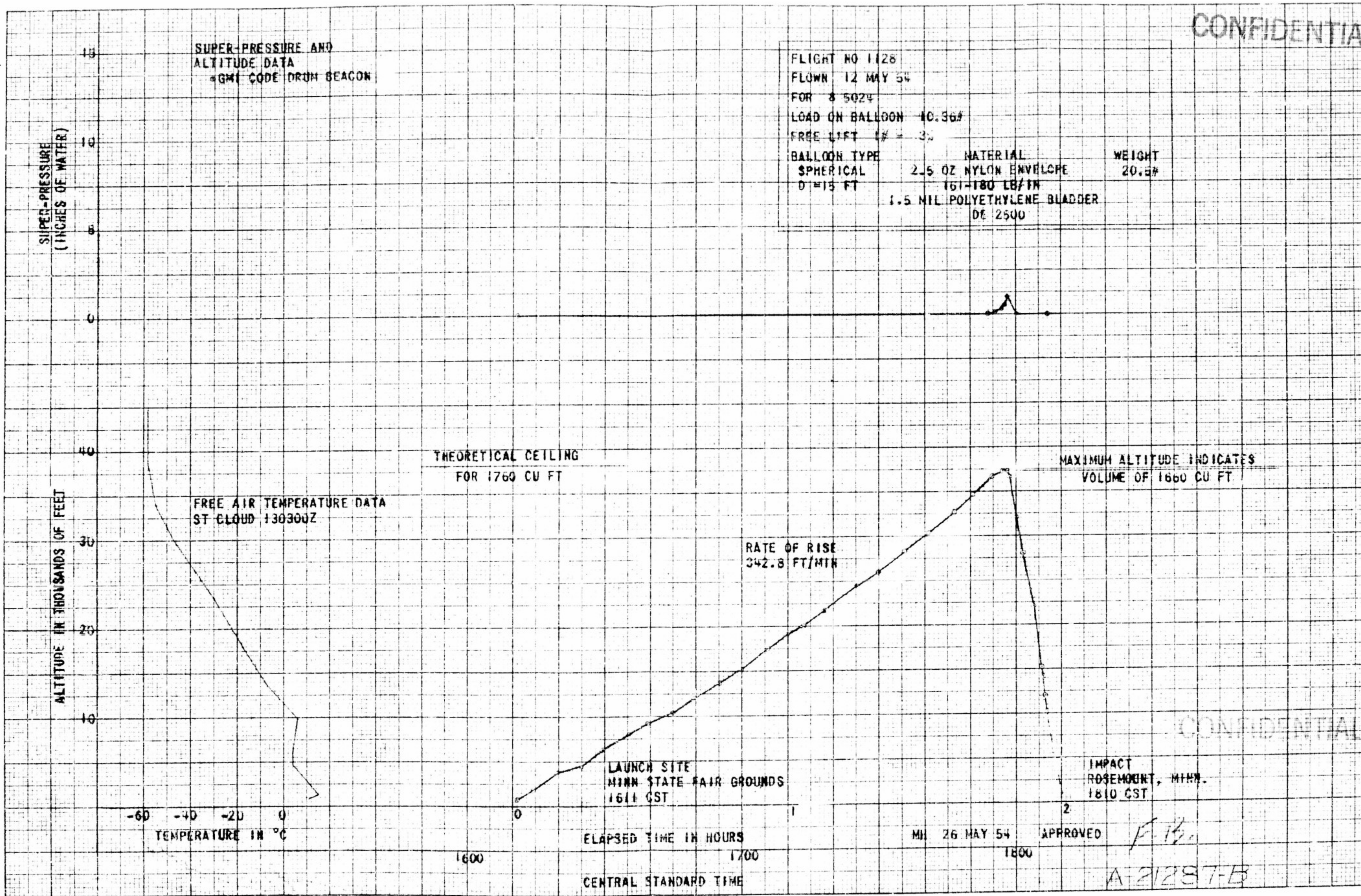


M.H. 25 MAY 54 APPROVED F.B.

A 21285 B

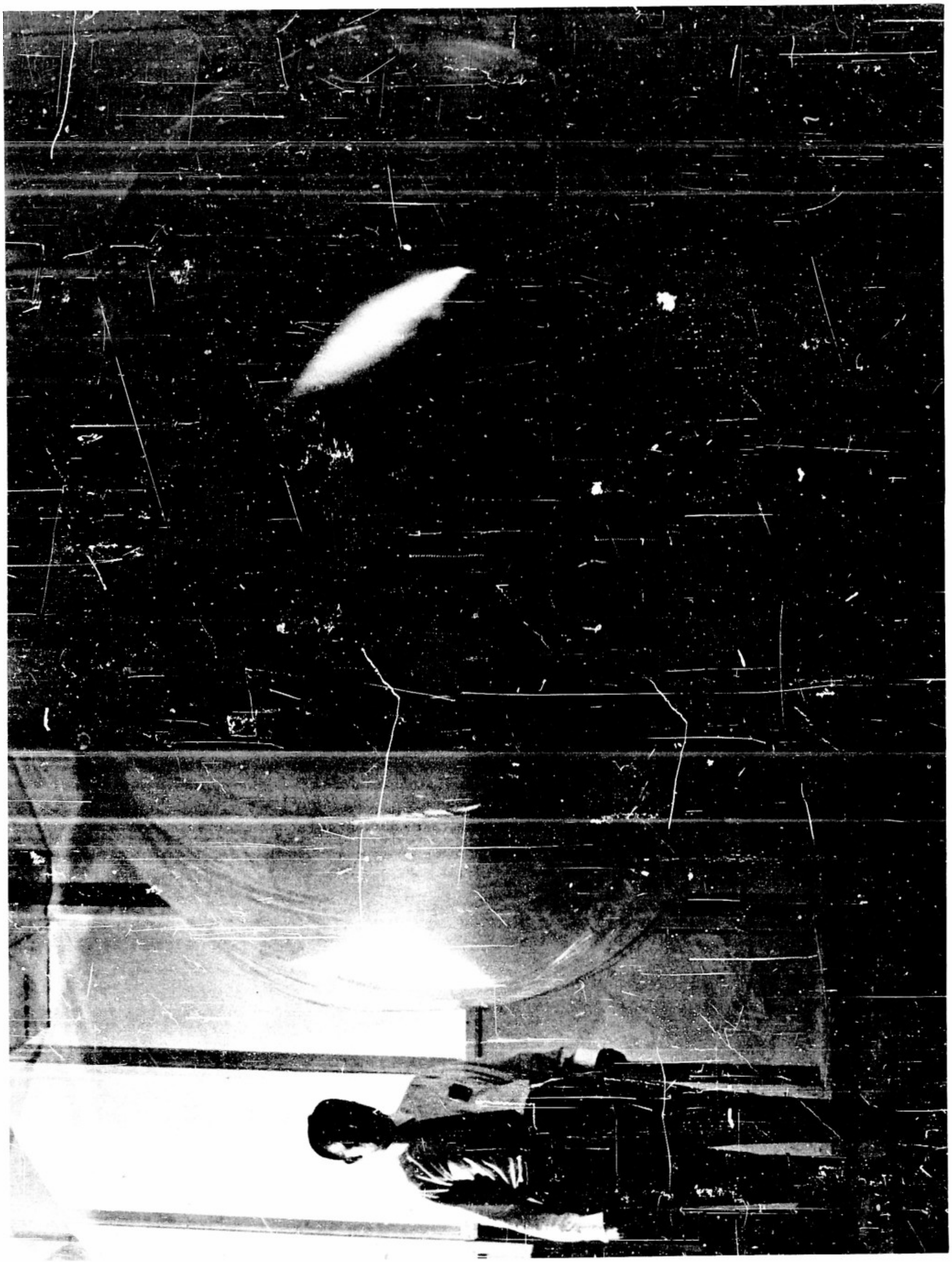
GENERAL MILLS, INC., ENGINEERING RESEARCH AND DEVELOPMENT DEPARTMENT: MINNEAPOLIS, MINN.

SEP 28 1954



GENERAL MILLS, INC., ENGINEERING RESEARCH AND DEVELOPMENT DEPARTMENT: MINNEAPOLIS, MINN.

SEP 28 1954



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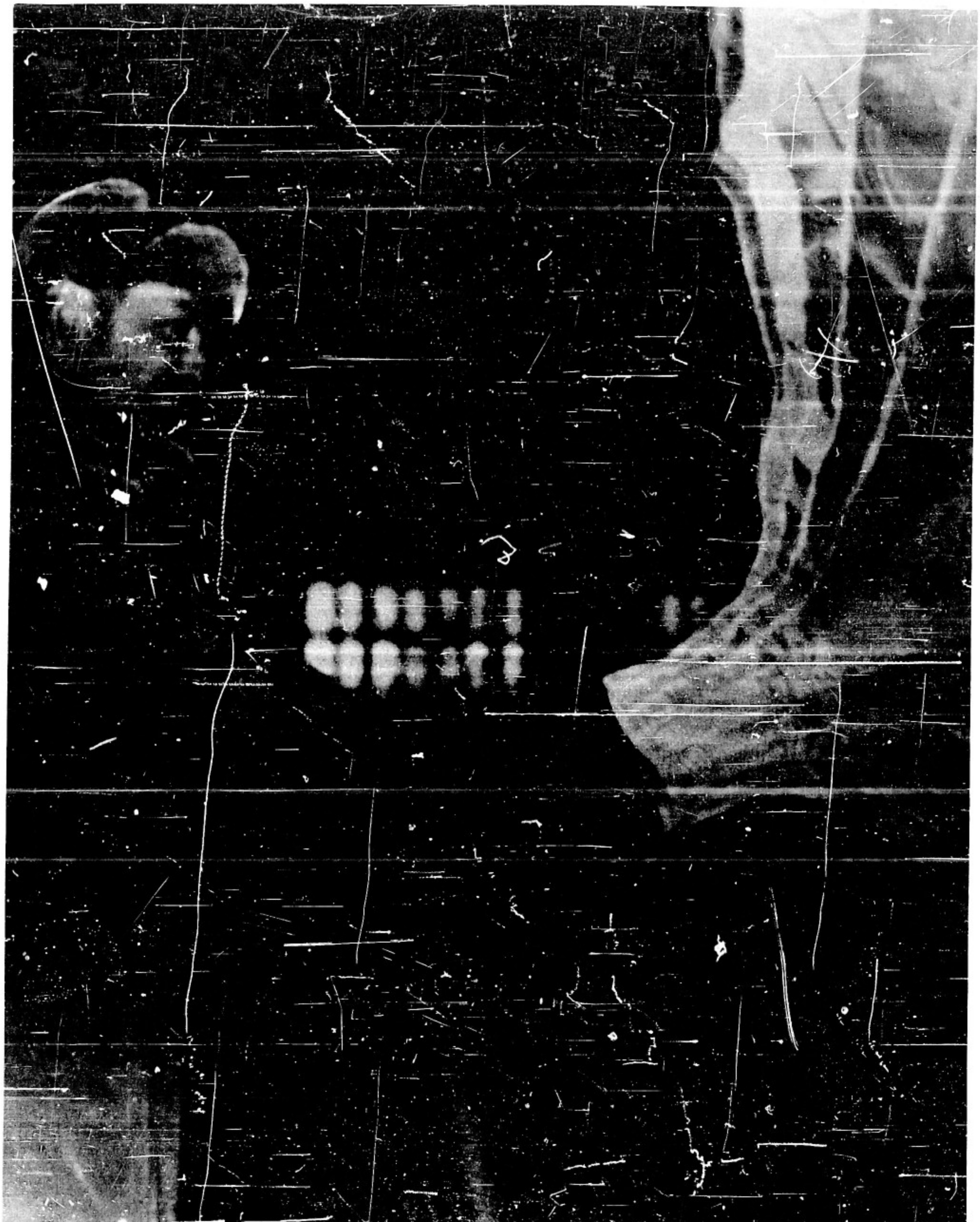

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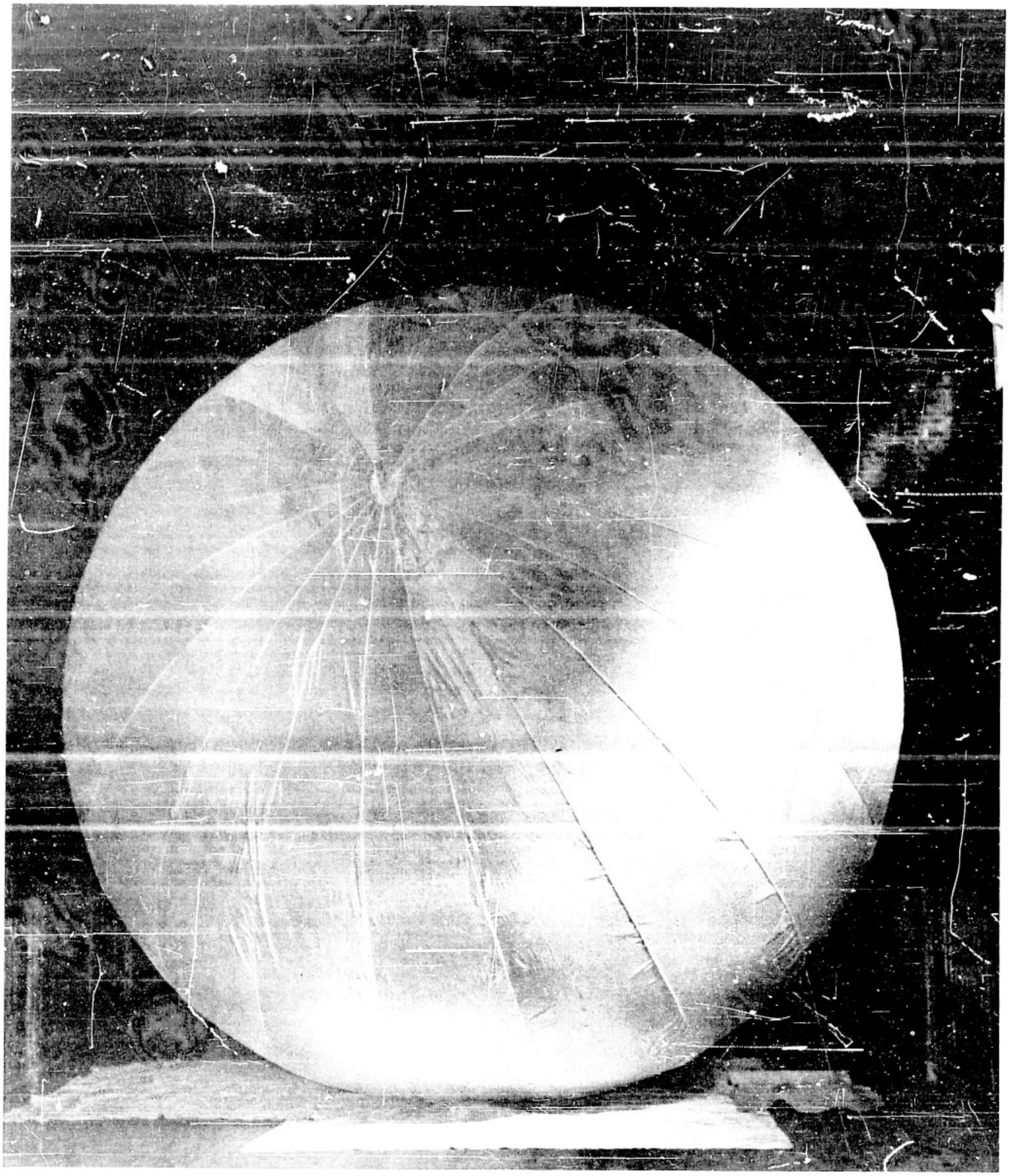

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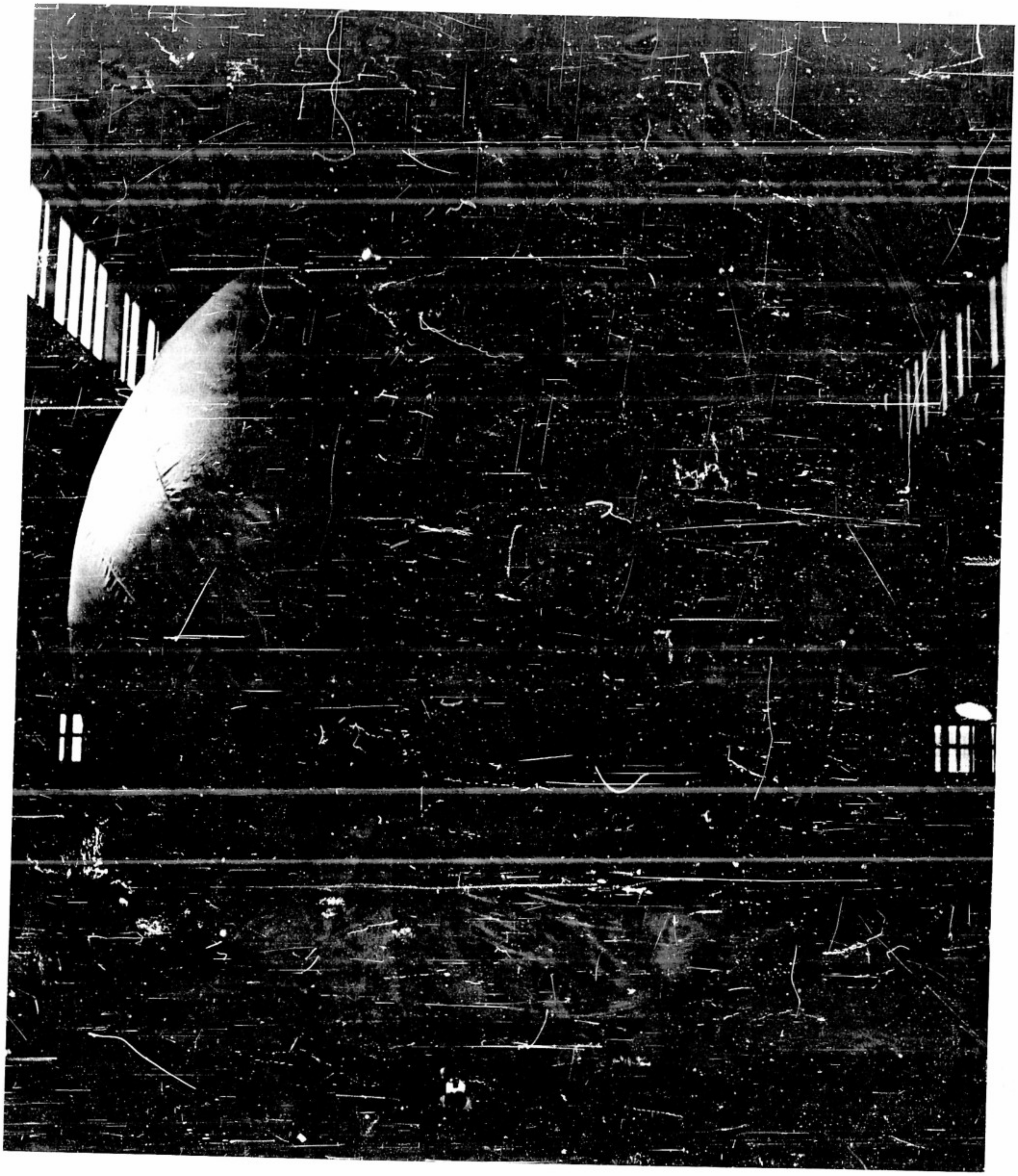

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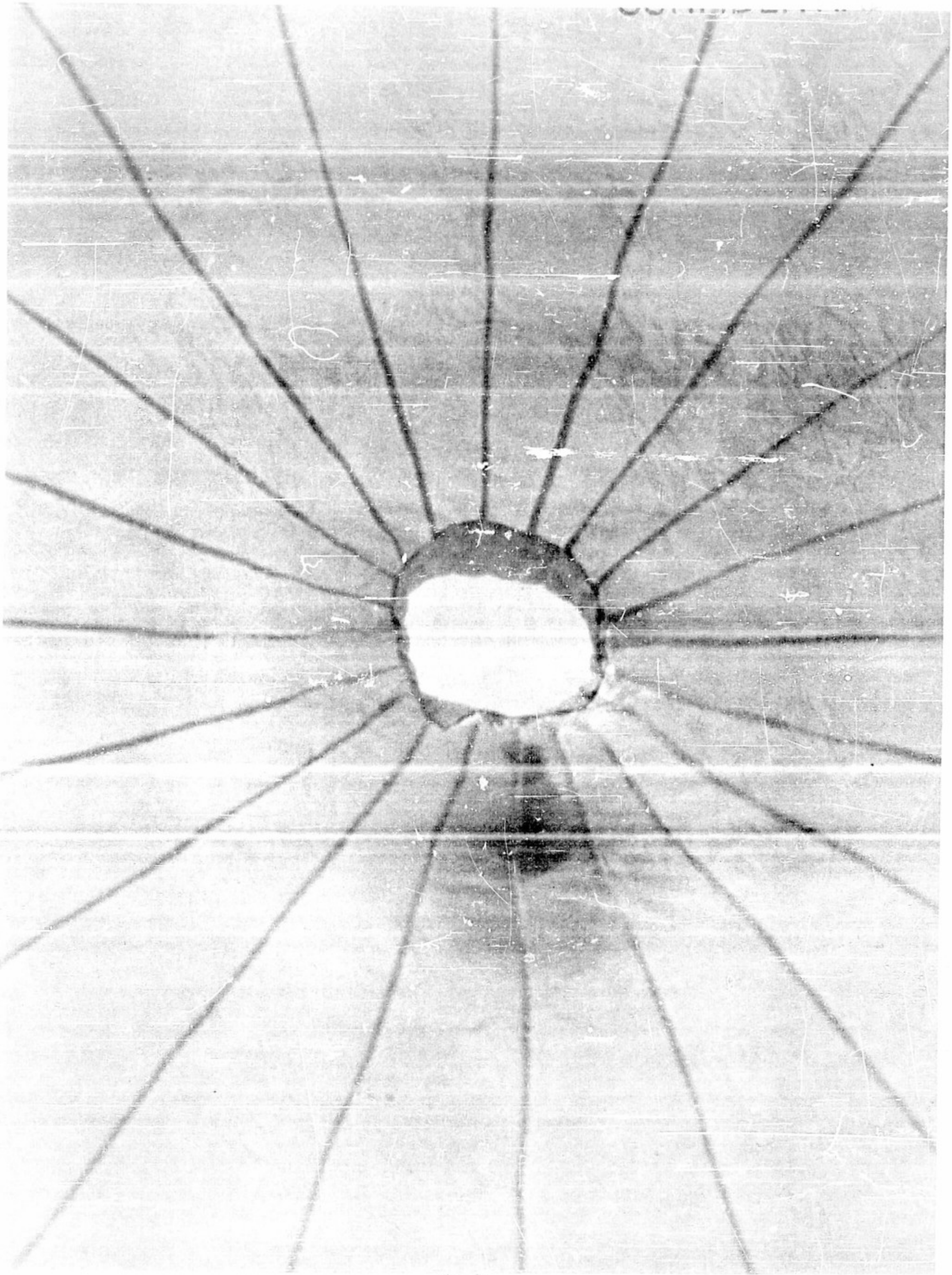

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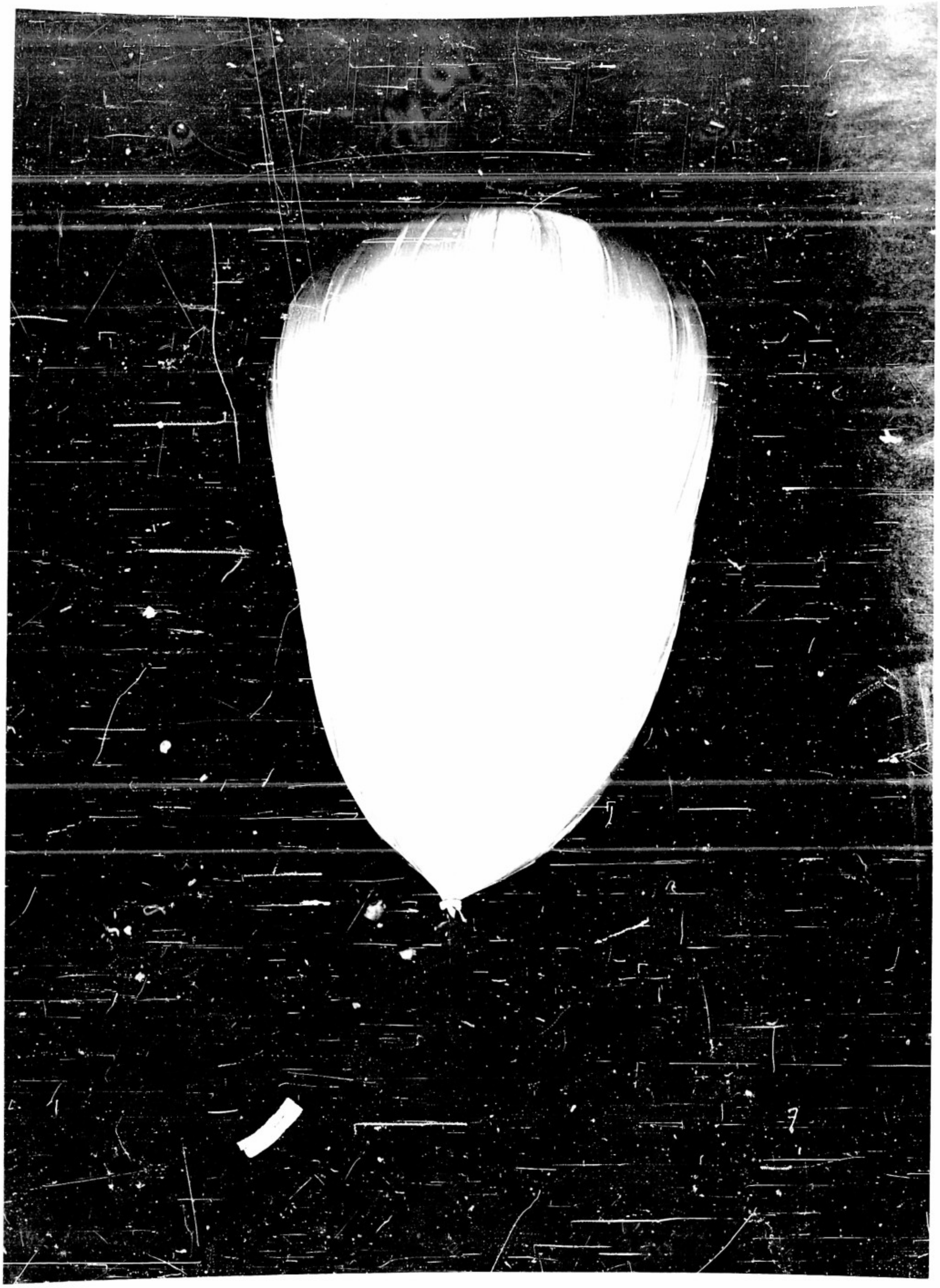

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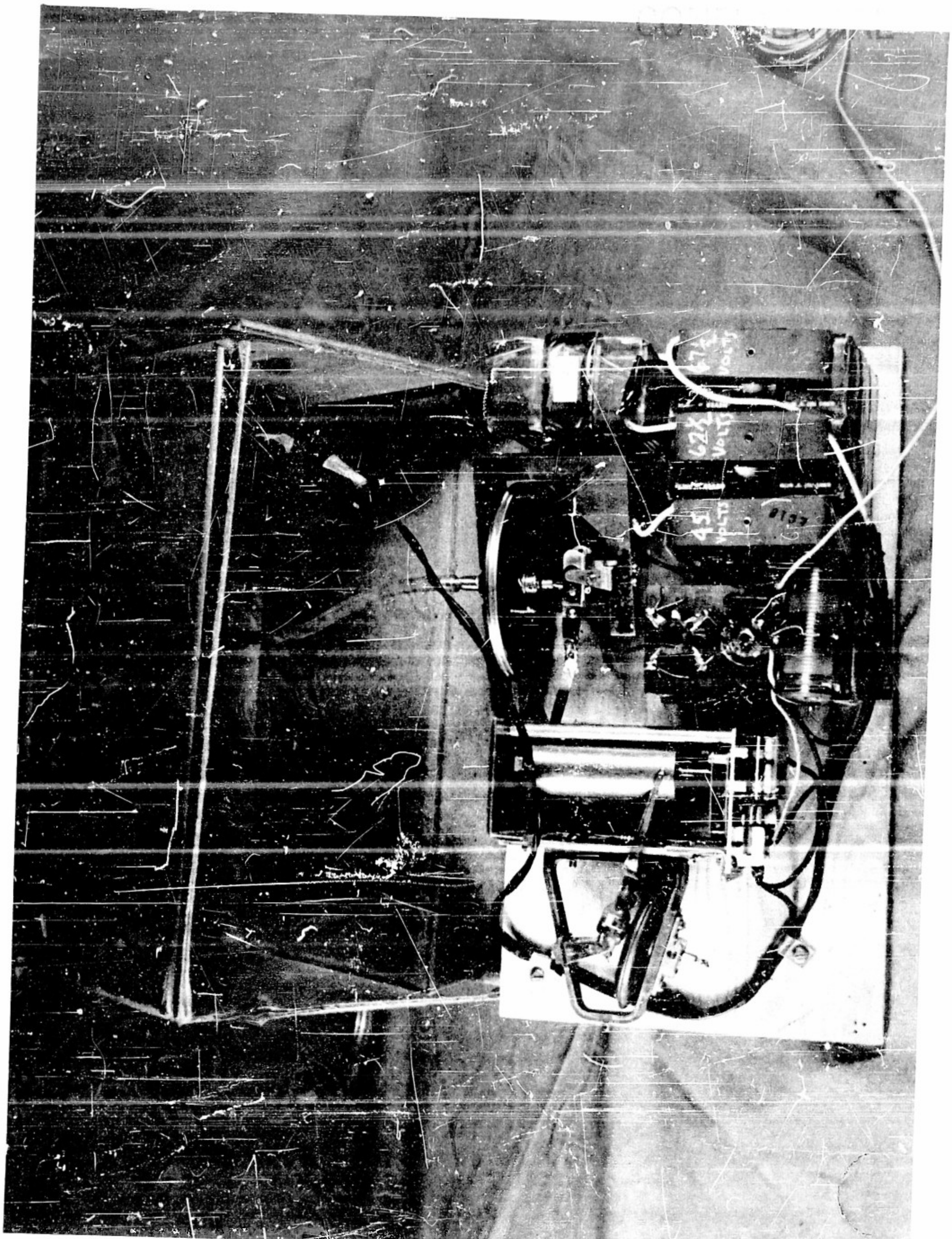

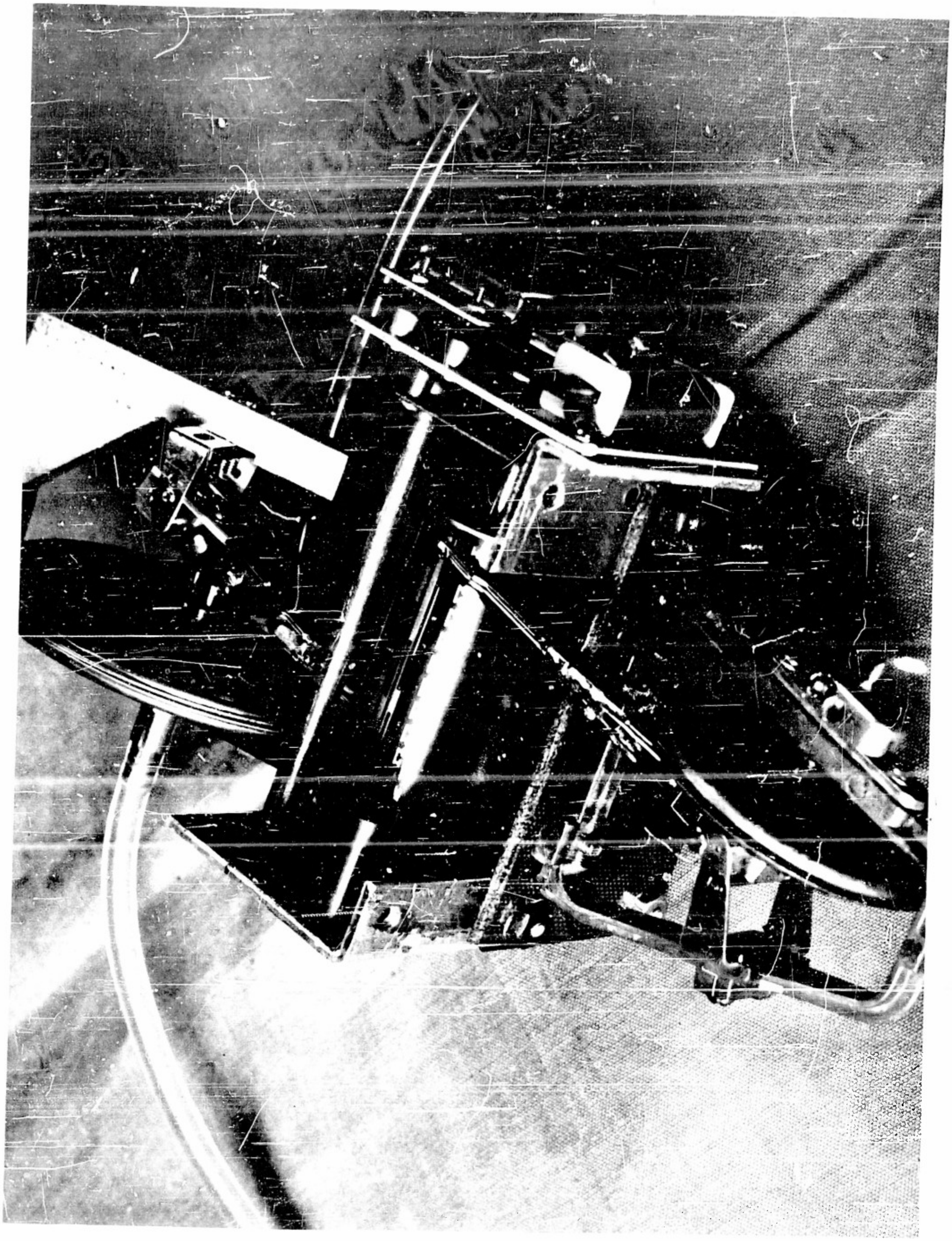

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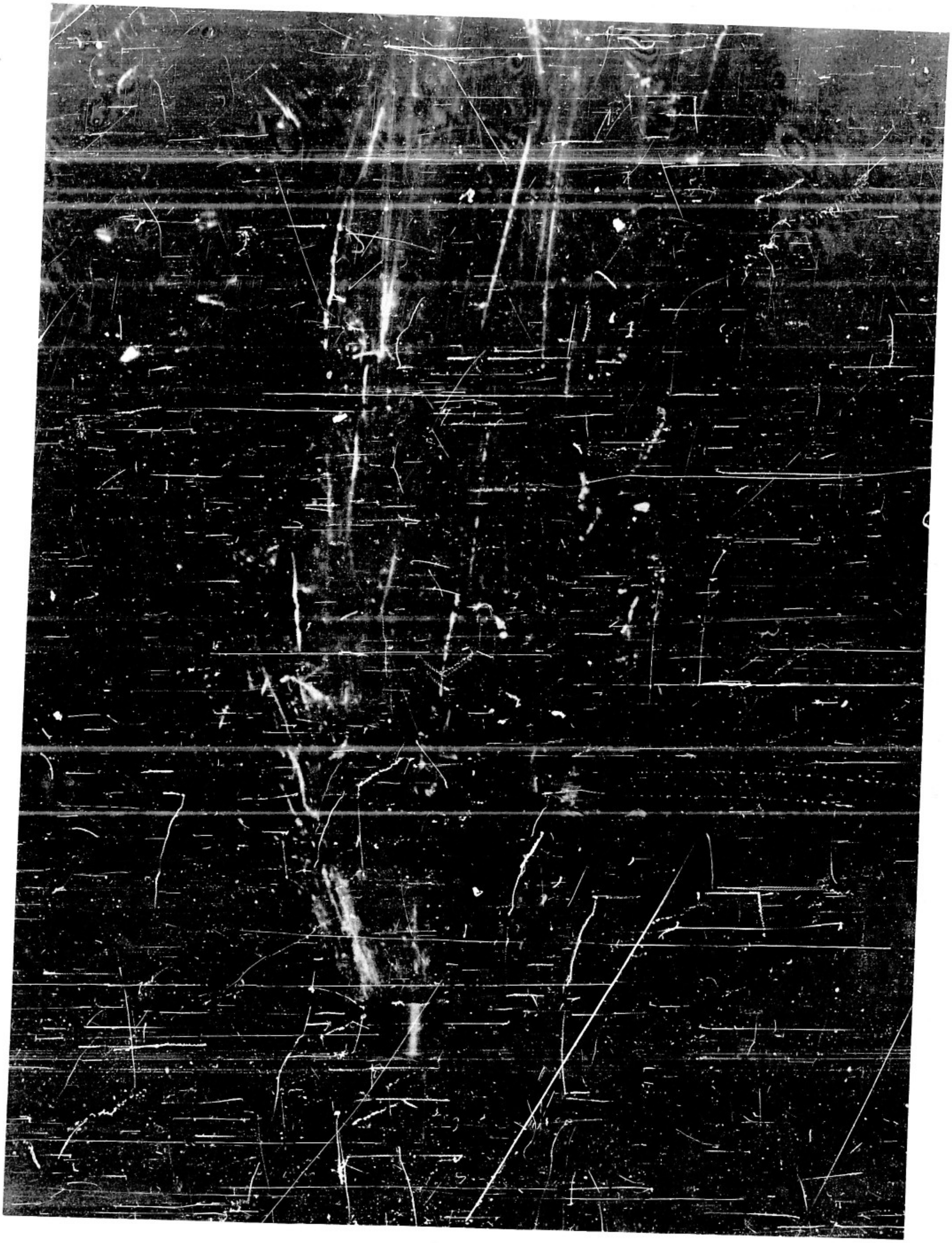

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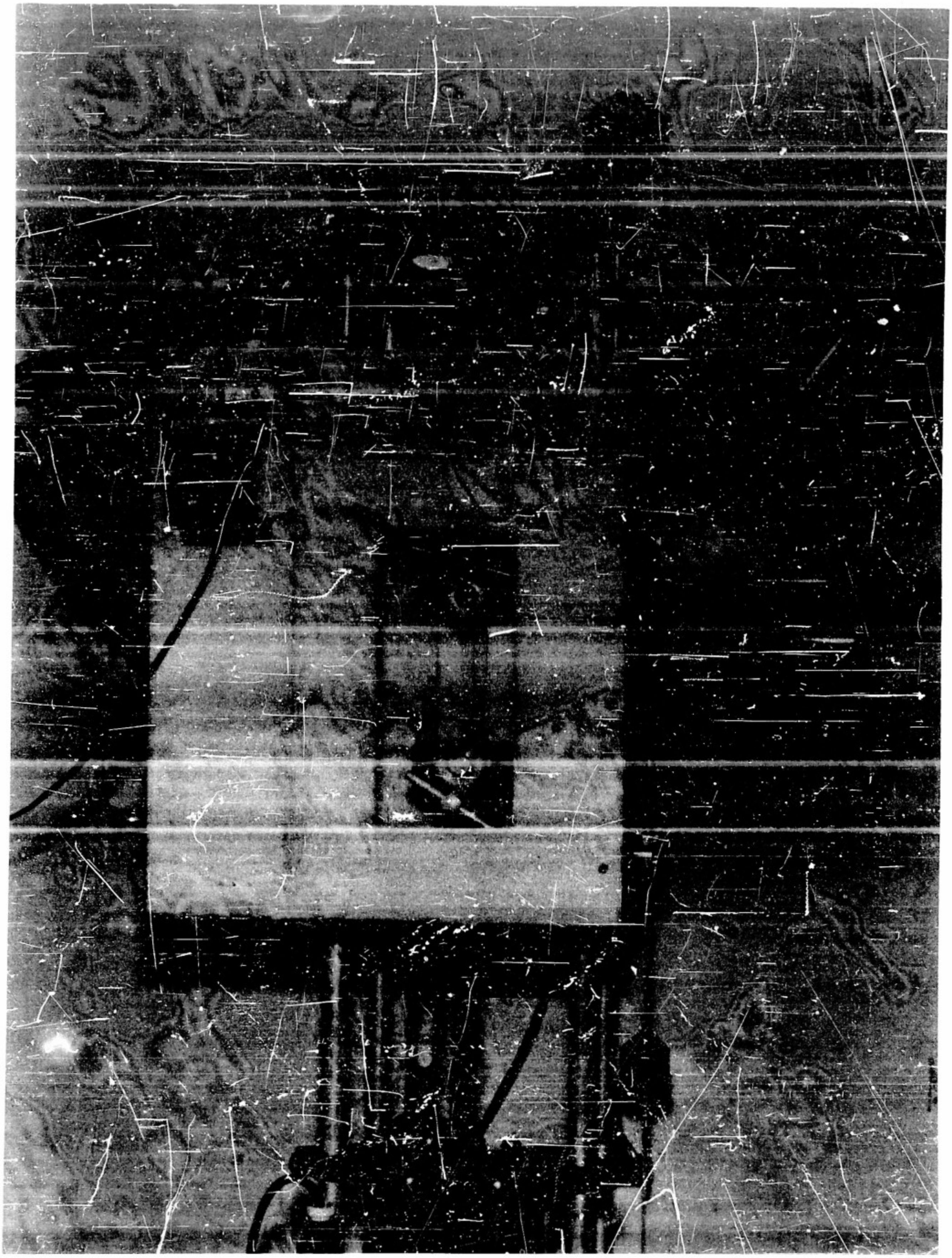

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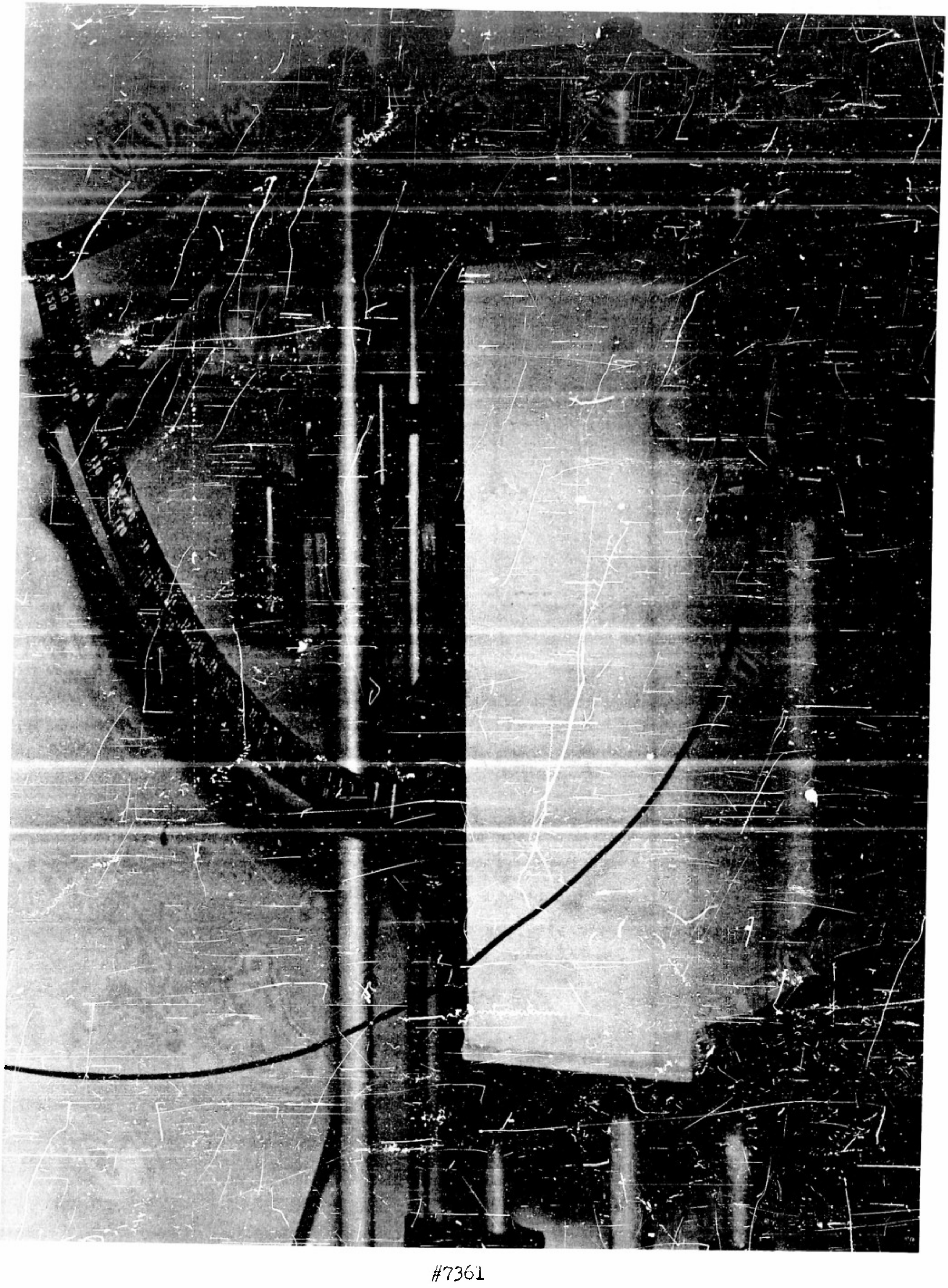

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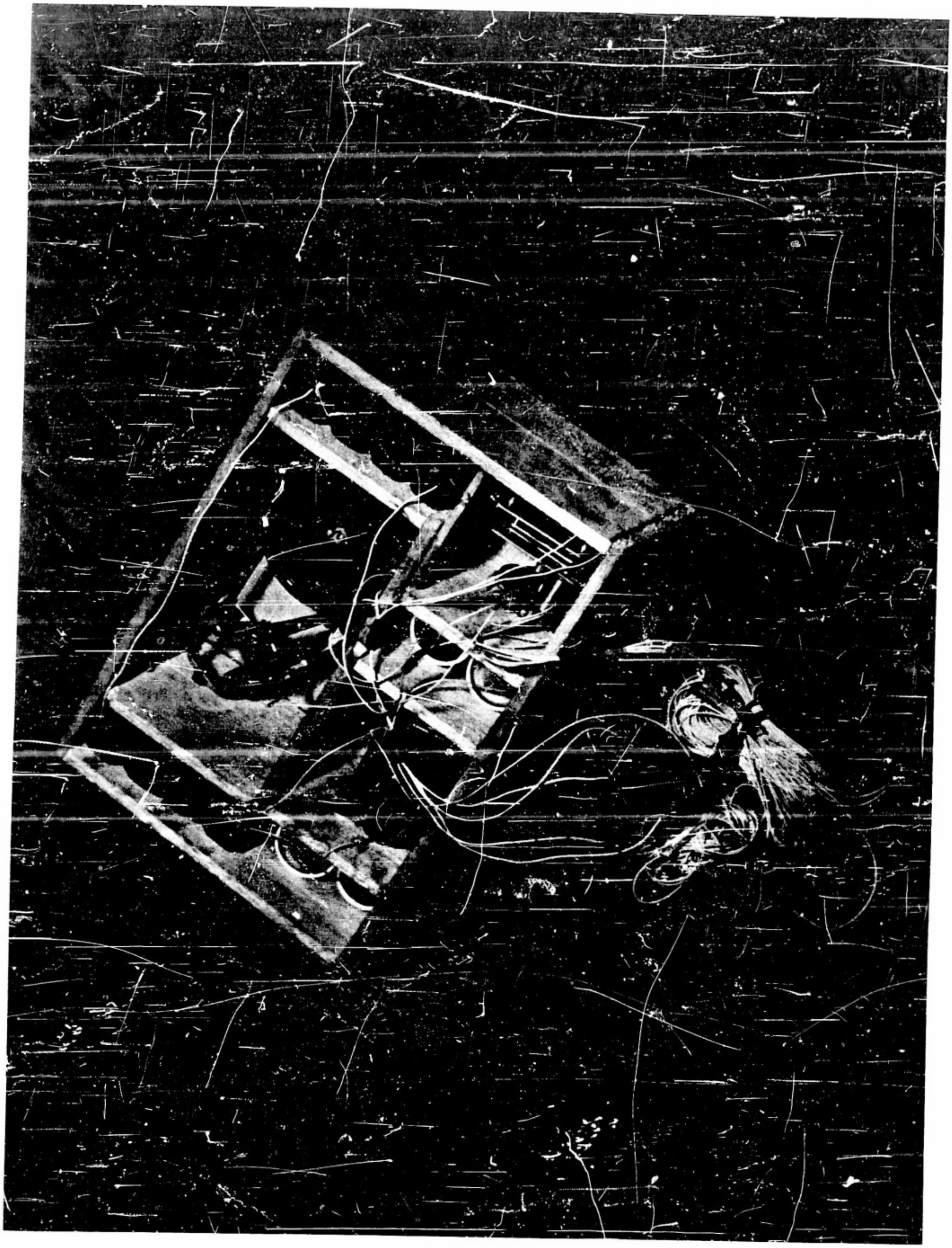

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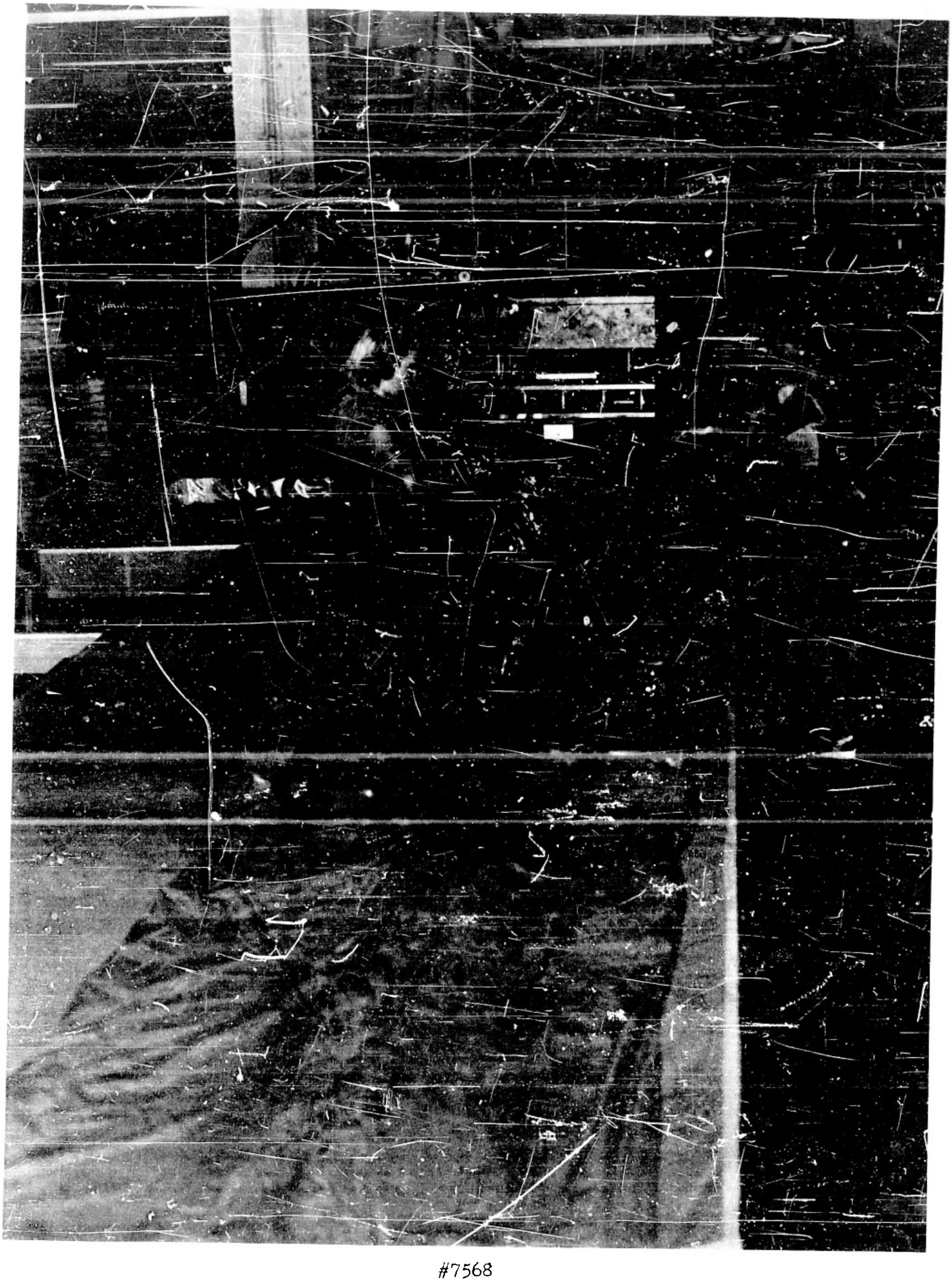

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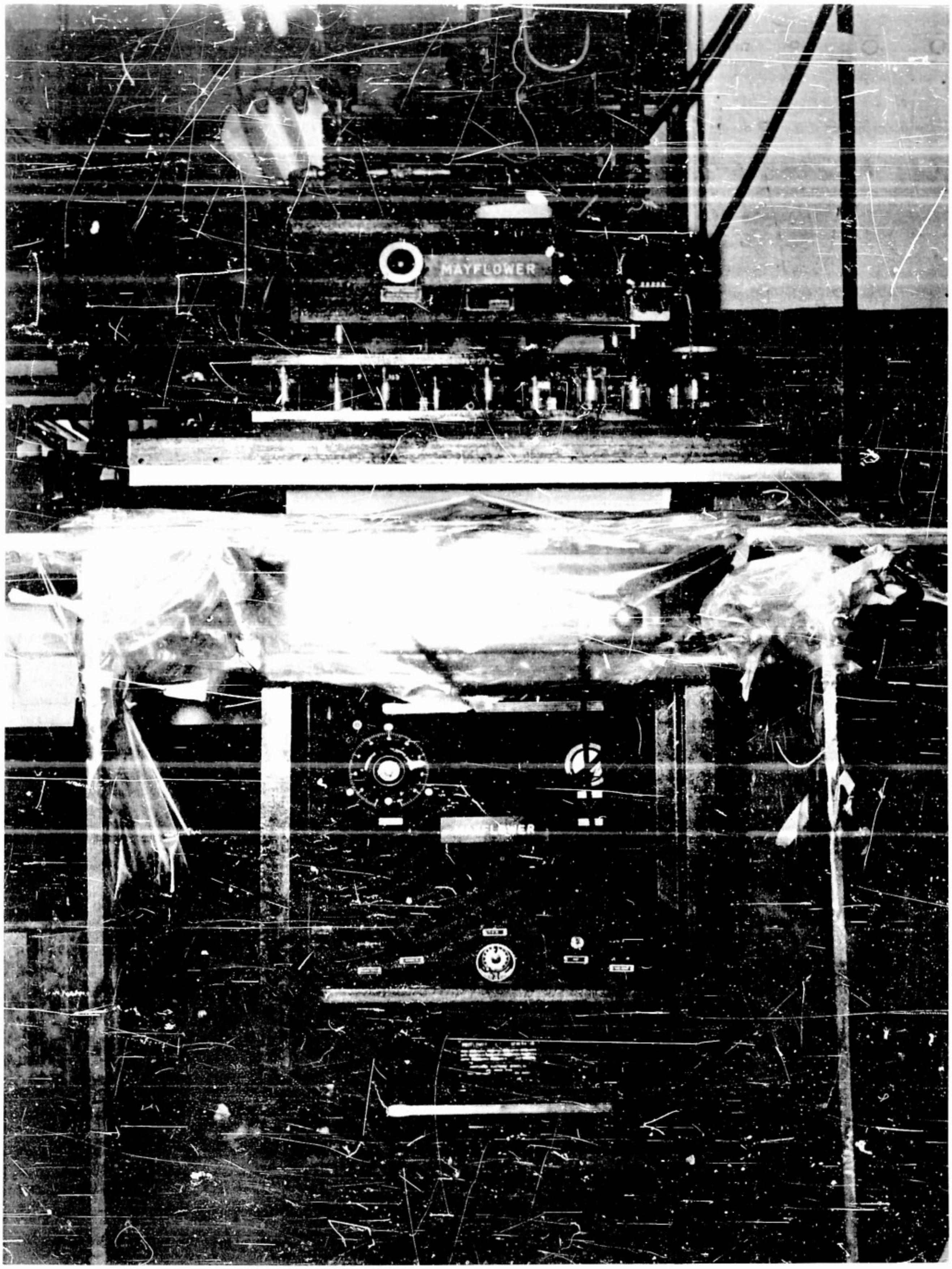

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